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MACHINERY.

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A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY.

CONTENTS.

DOCK TRIALS OF THE OREGON. G. W. DICKIE.

BOILER ROOM ACCIDENTS. W. H. WAKEMAN.

PECULIAR LOCOMOTIVE EXPLOSION.

IN A MODERN SHOP. FRED H. COLVIN.

THE SLIDE RULE IN THE SHOP. WILLIAM COX.

FORCED VS. NATURAL (?) DRAFT. PETER H. BULLOCK.

A FEW SHOP KINKS. JOHN T. USHER.

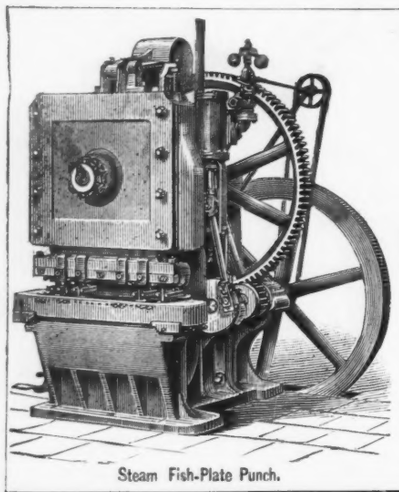
DESIGNING STATIONARY ENGINES (2). THEO. F. SCHEFFLER, JR.

RESISTANCE OF TRAINS OF MECHANISM (2). LEICESTER ALLEN.

HINTS FOR MACHINISTS AND ENGINEERS. JAMES F. HOBART.

WHAT MECHANICS THINK.

VARIOUS SHORT ARTICLES.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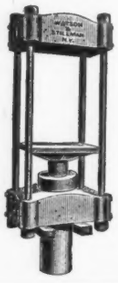
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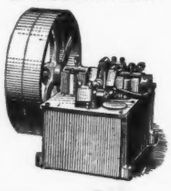
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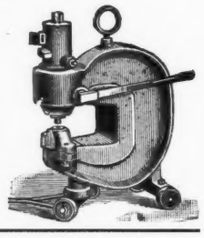
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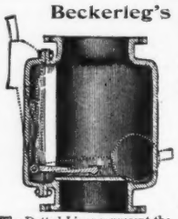
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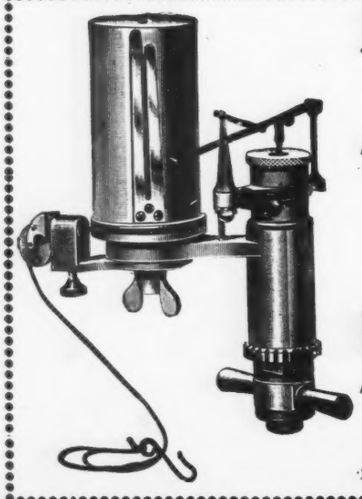

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MACHINERY.

VOL. I. November, 1894. NO. 3.

PRELIMINARY OR DOCK TRIALS OF A BATTLE-SHIP AT SAN FRANCISCO.

G. W. DICKIE.

IN connection with the building of a portion of our new navy at the Union Iron Works, San Francisco, a method of conducing the first or dock trials of the machinery has been introduced, which we think will interest the readers of MACHINERY.

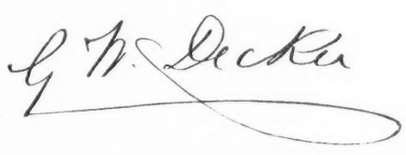
The whole water front of San Francisco consists of a mud-bed of great depth and very soft, the necessary depth of water being maintained by constant dredging. Consequently the depth of water at all the wharves is just sufficient to enable vessels to be moved, and at most of the wharves a large loaded vessel is usually in the mud at low water.

Owing to this mud being so close to the sea valves, through which the circulating water for the condensers and water service for the bearings has to be taken, it was found impossible to make any dock trials at the works without the risk of having journals ruined if water was applied to them, or the condensers and pipes choked with mud.

This was at first considered a great disadvantage, but like most natural obstacles, the necessity of the case resulted in a better method of conducting such trials.

Right in front of the works, about a half mile from the docks, very substantial moorings have been laid, with a large steel buoy, to which the vessel is secured by simply passing a large manilla hawser through the ring in the buoy, both ends being secured to the riding bitts on the fore deck of the vessel, so that when one end is let go, the vessel is free.

There is about fifty feet of water at low tide at these moorings, so that all pumps can be operated in clear water.



For some time past the *Oregon* had been waiting for her belt, barbette and turret armor, and in consequence was ordered docked, to have her bottom cleaned and painted. This required her to be moved from a berth she had occupied, and it was decided to make her preliminary trials before she returned. Sufficient coal was placed in the bunkers before leaving the works for these trials, it being the rule to use the same kind of coal as will be used on the official trial, so that experience is gained in its use.

On Monday, the 13th of August, the *Oregon* was at the moorings, and the testing of steam-pipes, etc., required by the engineer inspector, was completed that night, enabling steam to be raised in all boilers on Tuesday. The air and circulating pumps of the auxiliary condenser, of which there is a set in each engine-room, were the first to go into service, so that the steam used in trying the numerous auxiliaries might be condensed and returned to the boilers. One of the dynamo engines had been running for a week exhausting into the atmosphere. This was now turned into the auxiliary exhaust system.

Next the main circulating pumps were started, sending the water through the main condensers, this important function being successfully brought into operation. The air pumps being independent in this case, next receive attention, also the light service pumps that take the water discharged from the air pumps, and deliver it to the feed tanks, which are placed between the two sets of main boilers.

Having all these running satisfactorily, the main and auxiliary feed pumps come next. These are placed close to the main feed tanks in the fire rooms, forward and aft of them, being all ready to respond to any demand that might be made upon them.

Next there are eight fire-room blowers, one in each fire room, operated by high speed compound engines of a special design adopted for this purpose by the Union Iron Works, which respond very readily, having all been tested under steam at full speed in the shop before being placed on board.

It is now late on Tuesday evening, and having seen the hydraulic pumps for the steering gear and the gear itself all in motion, it was safe to say that to-morrow (Wednesday) would see the main engines move.

Accordingly, prompt at 9 o'clock A. M. the Works' tug left the dock and placed on board the *Oregon* the Government engineer and the naval architect, who were to look on and report to the Navy Department, the president and manager of the works, with some friends of the company.

Soon the main engine's auxiliaries were in motion, and the chief engineer of the works moves the reversing lever of the starboard engine. The links are moved from ahead to astern perhaps a score of times, with just a breath of steam admitted to warm the cylinders. Then a little more steam and the cranks begin to move a little, first one way, then the other, as the links move into ahead or astern gear. Now a little more steam, and as the links move into ahead gear the first revolution is accomplished. A few more turns and the links are moved to go astern.

The response is prompt, and the little party moves to the port engine-room, where the same programme is carried out with equal success.

The Captain is now notified that orders can be received and carried out in the engine-rooms from the pilot house. He orders the first officer to let go. One end of the hawser is quickly released. The steam winch pulls it through the ring on the buoy. "Go ahead slow," is telegraphed to each engine-room, and the battle-ship *Oregon*, whose engines had made their first revolution only five minutes before, is under way and moving out amongst the shipping to a clear space in San Francisco Bay, which is well adapted for such preliminary trials. A straight course of twelve and one-half knots can be run between Hunter's Point on the south and Red Rock on the north. And the *Oregon* is now headed for the south end of this run, about two and one-half knots south of the Iron Works.

Gradually the big ship gathers headway, more steam is given the main engines, until both sets are making 66 revolutions per minute, giving about nine and a half knots speed to the vessel. According to the trial programme this is to be the speed for the first day.

Everything proceeds very orderly in the engine-rooms, a strict watch being kept on all moving parts, the only disturbing element being the air pumps, which are of the geared type, and although they are doing their work very effectively, they are like some people who do good work, but make too much noise about it.

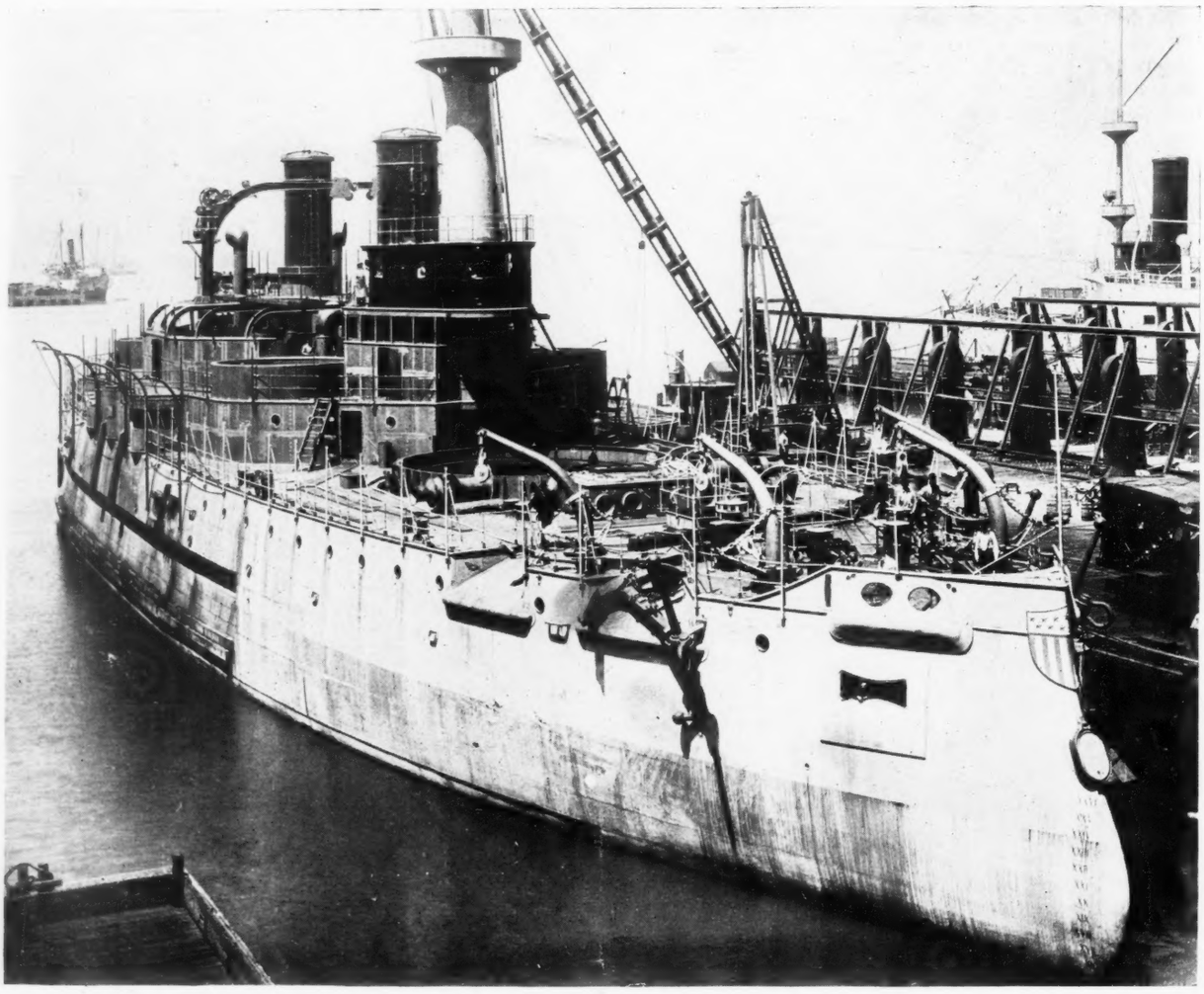
After three hours' run at 66 revolutions, during which careful notes were made of how everything worked the engines were speeded up to 82 revolutions for about one hour cards being taken and the working carefully noted, after which the trial for the first day ended, and the vessel returned to her moorings.

From the information obtained on the first day certain little adjustments were thought necessary in the valves of the air-pump engines, and on that account no run was made on Thursday.

Promptly at 10 o'clock on Friday morning the *Oregon* was again under way. The first movements of the main engines are not watched with the same interest this morning, as they had run for hours on Wednesday at 66 revolutions and for a litle while at 82 revolutions; so this day they were soon speeded up to 80 revolutions, and kept at that speed for four hours, every moving part being carefully attended to, the speed of the ship being eleven knots ; horse power, 2,690.

For an hour at the close of this day's run the engines are allowed to run at 100 revolutions, the ship making thirteen and one-half knots, the horse power being 4,064, and being fully up to the programme was accepted as very satisfactory, and expectations for the next day were very high.

On Saturday morning the inspectors and Works' officials were all on board in good time, and the start was made promptly at 10 o'clock. Within a few minutes of the start the engines had reached the revolutions of the day before, and for three hours the engines were kept at a steady speed of 105 revolutions, the ship making a little over fourteen knots. As no sign of trouble had yet appeared, the confidence of every one on board seemed to rise with the speed of the ship. The fire-room blowers were speeded up a little, the fire-rooms being still kept open; and as the steam went up, the throttle was opened a little further, and the last hour of Saturday's run was passed to the tune of 120 revolutions, the horse power being 8,160 and the speed sixteen and one-quarter knots.



BATTLE-SHIP "OREGON."

The trial having gone beyond the programme for the first three days, it was decided to remain at the buoy until Tuesday morn-day morning, the time being occupied in a close inspection of all parts of the machinery, this being considered necessary no matter how successful the trials had proceeded thus far. Nothing having been discovered to change the programme, Tuesday morning, the 21st, found the vessel ready for a further test.

Again at 10 o'clock the *Oregon* left her moorings, and in less

than half an hour the throttle was wide open, the engines making 126 revolutions, developing 9,500 horse power, which speed was maintained for six hours, without a hitch of any kind, the speed of the ship being about seventeen and one-half knots.

Thus, in four runs of about six hours each, this splendid set of machinery was worked up from the first movement to its full capacity, without having to stop at any time for any cause, from first to last, carrying out a programme of increasing the speed of the engines by 20 revolutions each day.

Much of this success is the result of going at once to clean deep water, and with the ship free. Not only are the engines tested by this method under normal conditions, such as prevail on official trials, but the steering gear, deck engines, and in fact everything, is tested together. It combines the dock with the contractor's sea trials, and saves cost. The present indications are that the success of the United States battle-ships will be as marked as that of her cruisers.

* * *

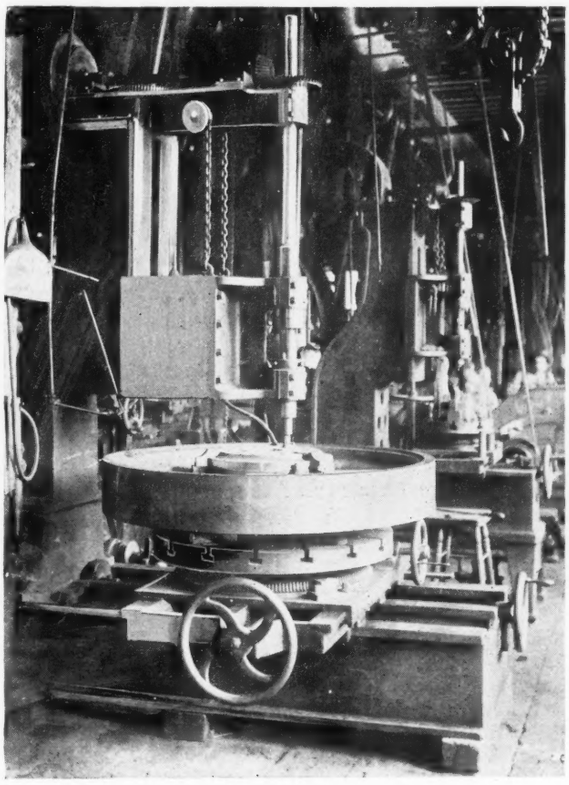
KEEP all the old belting rolled up and put away somewhere, not thrown into a corner, taking up three times the room it ought. Or, if it is past its usefulness in any capacity, don't have it around the shop at all.

* * *

IN A MODERN SHOP.

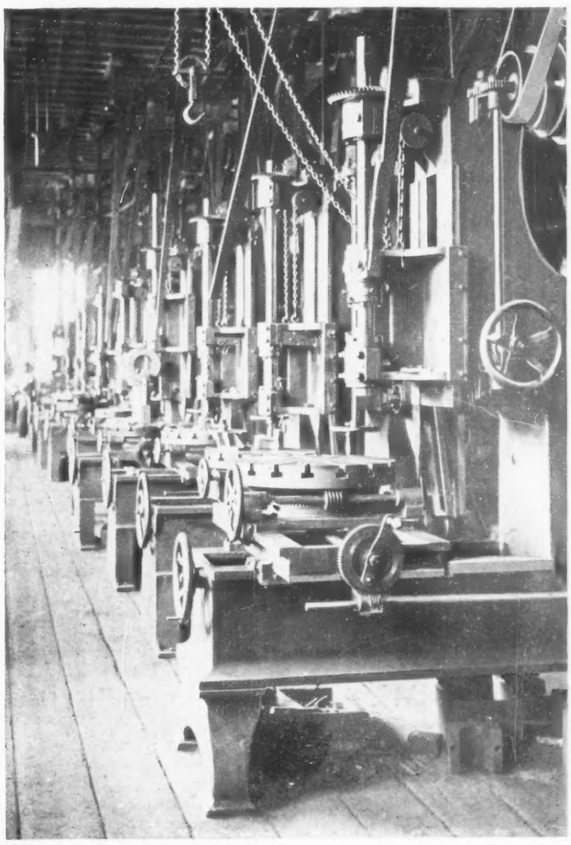
FRED H. COLVIN.

One of the most instructive features of mechanical training is to watch the introduction of modern methods and their results, and in this connection we reproduce a few photographs taken in in the works of The E. W. Bliss Co., of Brooklyn, showing some of their methods and the work produced. Much of their work is similar to that of many other shops and done in about the same manner. The feature that first impresses a mechanic in going into their main shop is the prevalence of milling machines, of the vertical type, which can very readily be likened to heavy drill presses, as they are constructed on very similiar lines, the milli g cutter moving vertically with the table confined to horizontal and rotary movements. One of these machines, and a good example of heavy construction, is shown in the first view, a heavy fly-wheel for a punching press being in position on the table, the end mill being used for cutting a radial slot in the hub for the clutch. As an indication of average speed of mills, the one shown, which is about 1¼ inches in diameter, was being run at 120 revolutions per minute. This, as in many other cases, depends much on the man doing the work.



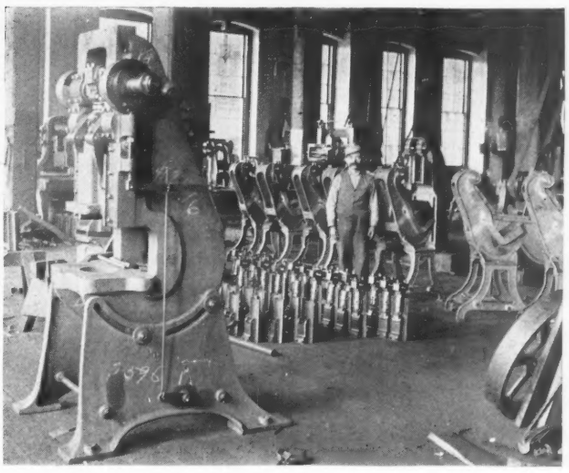
A VERTICAL MILLING MACHINE.

Mills of various sizes are used and much work is faced off here which is usually done on a planer, although these are by no means excluded, a large variety being used on work which seems more adapted for them. This seems to be a most sensible arrangement,



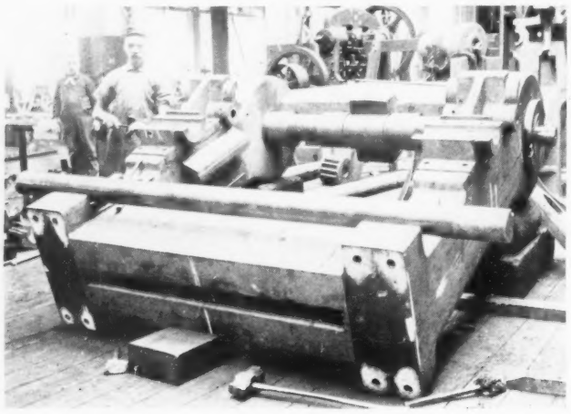
A ROW OF MILLING MACHINES.

though hardly satisfactory to the extremists on either side, but it shows that a careful application of both machines to the field in which each is best adapted is the economical method of shop management. Just where to draw this line may be an open question, and one which must be settled for every shop as the work seems to demand, but with few exceptions it is safe to say that both planer and milling machine have a distinct field in modern shop practice, with a tendency toward a wider sphere for the latter machine. The next view gives a row of these machines, not quite so large as the one first shown, but being solidly built are capable of fairly heavy work. Boring mills, boring bars and similar tools such as are found in most modern shops abound, and machines are made in quantity, as seen by the next view, which



IN THE ERECTING ROOM.

shows a corner of the assembling or "setting up" room. This also gives an idea of variety of work; the heavy press in the foreground and lighter ones in the rear, with parts of the slides and the adjusting screws. The heavier machines are erected in the bay beneath the electrically-driven travelling crane, making the handling of heavy parts easy and rapid. An idea of one of the heavier presses may be had from the last view, the comparative size of the workman giving a good idea of its large proportions. In the background one of the large forming presses can be seen, this being for heavy sheet metal work



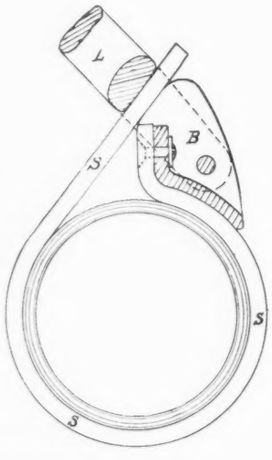
A HEAVY PRESS.

Designers and those interested can get good ideas of proportions of parts, distribution of metal, etc., from these views, as these machines are subjected to heavy work, and on the finer die work a slight springing of parts means damage, if not destruction to the dies, making rigidity a necessary feature. Much may be learned by careful study of the designs which have proved satisfactory in use, and in this the photographic reproduction is of great assistance, as it gives a more correct idea of the whole machine than a line cut.

* * *

A PIPE WRENCH.

Having considerable pipe work to do which was largely brass and copper pipe, and finding no wrench that would grip the pipe and not leave a mark, the one shown below was devised and has not been used by any one else to my knowledge. A light brass casting B was made about 2½ or 3 inches wide and of the section shown, with the portion over the rivets extending the whole width for a gripping surface. The holding part of this is the belt or straps S S, which was a piece of new belt 2½ inches wide in this case. Three rivets held it in place, as shown, and the forked lever L was hinged so as to grip the belt between the surfaces shown, when it was pulled in the right direction, while a reverse movement loosened the grip. The rest is plain, for by passing the belt around the pipe (or slipping it over when convenient) and through the opening, drawing tight and pulling on the lever, the belt tightens and a good frictional surface is presented, which will do nicely for ordinary work. For heavier work this can be modified to suit, and forms a basis for a good wrench for pipes which must not be injured.



* * *

We note the resignation of Mr. F. F. Hemenway from the editorship of the *American Machinist*, where he was so well and favorably known for many years. Its readers are to be congratulated that Mr. Fred J. Miller and Mr J. G. A. Meyer, the former associates, have succeeded him, for under their able guidance the standard will be fully maintained.

THE RESISTANCE OF TRAINS OF MECHANISM—2.

Leicester Allen.

It is often the case, however, that this condition of things is reversed, and the leverage is in favor of the resistance. Such an arrangement is illustrated in Fig. 2, wherein we have a train of rock-levers having their journals at A_1 A_2 A_3, etc., these being the journals upon which they work. Here the useful work to be performed is represented in the lifting of the four weights B_1 B_2 B_3 B_4, and in the transmission of power for this purpose from one lever to another through the medium of the links D_1 D_2 D_3 D_4. Each element of the system, in the sense in which I use the word *element* in this discussion, is that part of the train respectively lifting one of the weights D_1 D_2, etc. The first element of the train, therefore, consists of the levers L_1 L_2 and the link D_1. The second element of the train consists of the levers L_1 and L_3 and the link D_3, and so on for each weight. In this train, for each element, there is likewise six places where friction will be generated, except in the last or lower element, which has but five. In computing the force necessary to be applied at A_1, in the direction indicated by the arrow at that point, in such manner as to simultaneously lift all the weights, the leverage must be taken into account.

In further pursuing this subject and referring again to the figure, let us suppose all the elements of the train to be removed except the first, and use the following notation:

Let Fn represent the resistance of the entire train, r the resistance due to the performance of useful work by a single detached element of the train, p the fraction of the useful work consumed in friction, and n the number of elements comprised in a train of the character under consideration.

Then if, as we have assumed, all the elements of the train but one are, so to speak, switched out of service, leaving only this one element to be moved, we can represent the force required to start it by $(r+p\,r)$, of which the part represented by $p\,r$ is demanded, not by the useful work to be performed, but by the frictional resistance due to pressure upon bearings. And while, in coupling on more elements, $p\,r$ will increase exactly in proportion to the increase in number of the elements operated together, the total passive resistance will increase as pressure increases under increased load in a manner analogous to the increase of credit on account of money deposited in a savings bank and drawing compound interest, in a case where an additional definite sum, the same as that first deposited, is periodically deposited to the credit of the account at the time the interest is added. The friction of the connection between any two elements must also be added when each element is connected on. In the case under consideration this latter would be the friction of the teeth of the wheels represented in Fig. 1. As this is included in our estimate of the percentage of the force required to start a single element which is absorbed by friction, we may write $F_1=(r+p\,r)$,

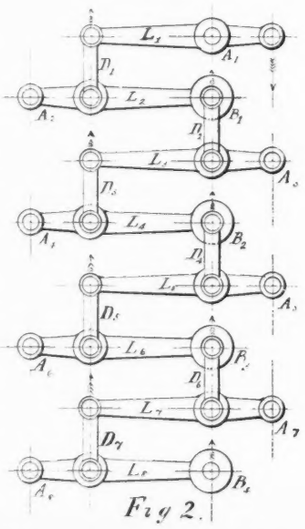


Fig 2.

wherein F_2 symbolizes the total force necessary to move a single element of the train. When a second element is coupled on, a force F_2 is necessary to apply to the first element in order to set both in motion. This force F_2 is that required to drive the first element alone and overcome the frictional resistance of the connection between the two elements, plus that required to drive the second by itself and overcome the frictional resistance of its connection to the t ird when the latter is coupled on, plus the additional friction due to pressure upon the bearing of the first by the added load of the second element, which includes not only the load represented by the useful work of the second element, but that due also to its frictional resistance. This is, in our supposed case, equal to a fraction of the useful work expressed by p.

We may therefore write for the force required to start two elements of the train

$$F_2=(r+p\,r)+(r+p\,r)+p\,(r+p\,r),$$

which may be reduced to the form

$$F_2=2(r+p\,r)+p\,(r+p\,r).$$

If now a third element be coupled on, we have to use not only $(r+p\,r)$, the simple force required to start this element alone and overcome the friction of its connection with the fourth element, but also force required by the increase of friction due to this added load upon the second element, evidently the same as that for the first element will be when only the second element is coupled with the first; and we must add also force to overcome the increase of resistance due to the added load upon the first element. The force now needed to be applied to the first element, and through it to the second and third elements, may be found as follows:

$$F_1=(r\times p\,r).$$
$$F_2=2(r+p\,r)+p\,(r+p\,r).$$

Hence to start the three elements by force applied to the first of the series will require a force

$$F_3=3\,(r+p\,r)+2\,p\,(r+p\,r)+p^2\,(r+p\,r).$$

Now suppose a fourth element to be coupled on. The force required to start this element alone, including the resistance of its connection to a fifth element, were the latter connected on, is

$$F_1=(r+p\,r).$$

The force required to be applied to the third element to start the third and fourth together is

$$F_2=2\,(r+p\,r)+p\,(r+p\,r).$$

The force requisite to be applied to the second element to start the second, third and fourth is

$$F_3=3\,(r+p\,r)+2\,p\,(r+p\,r)+p^2\,(r+p\,r).$$

The force required to be applied to the first, to start all the four elements together, will be

$$F_4=4\,(r+p\,r)+3\,p\,(r+p\,r)+2\,p^2\,(r+p\,r)+p^3\,(r+p\,r).$$

We may now generalize this equation by taking n as the symbol for the number of elements in any train, and we may write

$$Fn=(r+p\,r)+(n\text{-}1)\,p\,(r+p\,r)+(n\text{-}2)\,p^2\,(r+p\,r)+(n\text{-}3)\,p^3\,(r+p\,r),$$

and so on to n terms of the series. This formula expresses the law we are seeking.

If there were no "*compounding*" of the friction, and hence of the force necessary to overcome its resistance, the first term of the second member of the formula would express the force needed to start a train containing n elements. Therefore the remaining terms of the second member of the equation will express the increase due to this *compounding*, a word which I borrow from the terminology of compound interest as equally suited to the present purpose.

Inspection of the formula shows that the increase is not independent of the quantity r, and that the *rate of increase* will be more or less rapid with interest in the number of elements in a train, not only with the increase of r, but with powers of p. This last being a potent cause of increase, it becomes important in the designing of mechanical trains to plan for keeping it as low as possible.

Some practical conclusions and an extension of the discussion to cases in which leverage modifies the formula, are reserved for a future occasion.

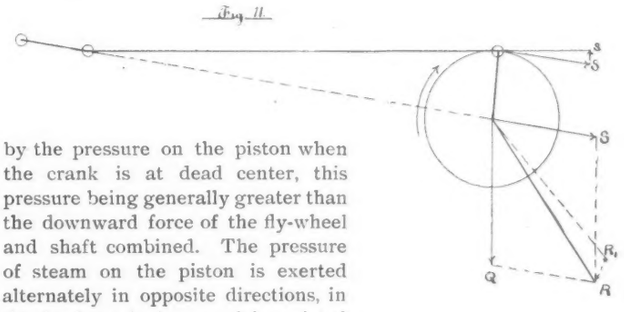
* * *

Don't imagine because a lathe or other machine is not being used that the counter-shaft doesn't need oiling just the same, for unless the belts are off and the counter-shaft is idle too, it needs just as much attention as though it were running. Neglecting this has caused more than one troublesome loose pulley, and the oiler should be made to attend to *all* counters, whether the machines are running or not.

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—2.

Theo. F. Scheffler, Jr.

One of the most important features of the engine bed is the main journal, and to thoroughly understand each detail it is necessary to illustrate and describe it. Figs. 6 and 7 show the detail of wedge; Fig. 8 is a plan view of journal showing arrangement of bolts and set screws for adjustment; Fig. 9 is a sectional view through center, and Fig. 10 a longitudinal sectional elevation through center of journal. As will be seen, the journal is designed in four parts, and is commonly called the quarter-box journal, for the reason that it parts on each quarter, which is a very desirable feature, as it allows for taking up the wear caused by the steam pressing on the piston throughout the length of the stroke, and also on account of disconnecting the shaft from the engine at any time, for by taking off the cap and lowering wedges C C, the gibs *d d* can be lifted out of position and the shaft readily raised. The wear on the bottom caused by the combined weight of shaft, pulleys and fly-wheel can be taken up by adjusting the cap. Mere rotative force in itself does not produce any pressure on the bearings. The pressure produced in the journals by transmission of power is uncertain in amount and direction. For example: A gear engaging in the horizontal plane has a tendency, if driven in one direction, to lift the shaft, and if driven in the opposite direction, to augment its weight. So with belts: they may exert pressure in any direction, or, may tend to relieve it. The pressure from this cause, whatever it may be, affects both the main and the outer journals alike. There are, however, two strains, that of the combined weight of shaft, crank disc, pulleys and fly-wheel, which is exerted in the downward direction, affecting both journals alike; the force of steam on the piston, and of reciprocating parts, which is exerted in the horizontal direction. The greatest force on the gibs *d d* is caused



by the pressure on the piston when the crank is at dead center, this pressure being generally greater than the downward force of the fly-wheel and shaft combined. The pressure of steam on the piston is exerted alternately in opposite directions, in the horizontal plane, and is resisted wholly in the main journal. To thoroughly understand the motion of crank forces we refer to Fig. 11. The heavy lines show the line of force when the crosshead is in the center of the stroke. We also observe that the force S always acts in the direction of the center line of cylinder, and that the force Q acts downward, and further, for connecting rods three times the length of stroke, the small force S causes the resultant R of the forces Q and S to vibrate between the positions of R and R, when the crank moves in the direction of the arrow, *i. e.*, throws over and tends to lift the shaft from its bearing, creating a pressure on journal-cap, which must be resisted by the studs *e e*. We will show later how this pressure is obtained. If the crank throws under, the small force *s* tends to press the shaft down on its bearing, relieving the pressure on studs *e e*. This diagram also illustrates where the greatest amount of wear takes place, which is where the resultant R intersects the circumference of the journal. To adjust the gibs *d d* we raise the wedges *c c* by turning the nuts on the studs *f f*; the wedges *c c* are held securely by means of the guide-pins *h h*, and prevents the wedges getting out of line. There is only one stud in each wedge for adjustment, which gives better results than if two were used; as with two, the engineer is liable to raise one side of the wedge higher than the other, causing unnecessary friction on the high side; one stud gives a more uniform bearing throughout the journal. It will also be noticed that both wedges and gib extend the whole length of the journal, giving a greater amount of area to the wedges, and reducing the pressure per square inch to a minimum. The cap, gibs and wedges are made of cast iron, and the wearing surface proper of best babbitt metal ¾ of an inch thick, dovetailed into the cap, gib and engine bed. The set screws *g g* fasten the gibs rigidly after adjustment

has been made. A good rule for calculating the length of main journal is to double the diameter of shaft, which, being 9 inches, gives us 18 inches for the length of main journal. To demonstrate this, and show that the above length is correct for this engine, we apply the following formula:

Let R=pressure on journal.
" f=coefficient of friction.
" d_4=diameter of journal of shaft.
" l_4=length of journal.
" N=number of strokes per minute.
" .0000325=a constant.
" Q=reaction at bearing due to weight.
" S=stress due steam pressure on piston at end of stroke.

We have already found (in the first article) the maximum pressure on piston is 25,125 pounds, so S=25,125 pounds and Q=5,000 pounds approximately.

$$R=\sqrt{Q^2+S^2}=\sqrt{5000^2+25125^2}=25617$$

pounds approximately.

Let f=.07.
" R=25617 pounds.
" N=340 strokes per minute.
" l_4=.0000325 f R N.

Therefore,

$$l_4=.0000325\times.07\times25617\times340=19.72$$

inches for length of journal, which is not far from the first calculation, and goes to show that for ordinary engines, where the fly-wheel is not excessively heavy, doubling the diameter of shaft will answer all practical purposes.* To calculate the maximum pressure on main journal cap, so as to determine the correct diameter of pillow-block studs, we will apply the following formula:

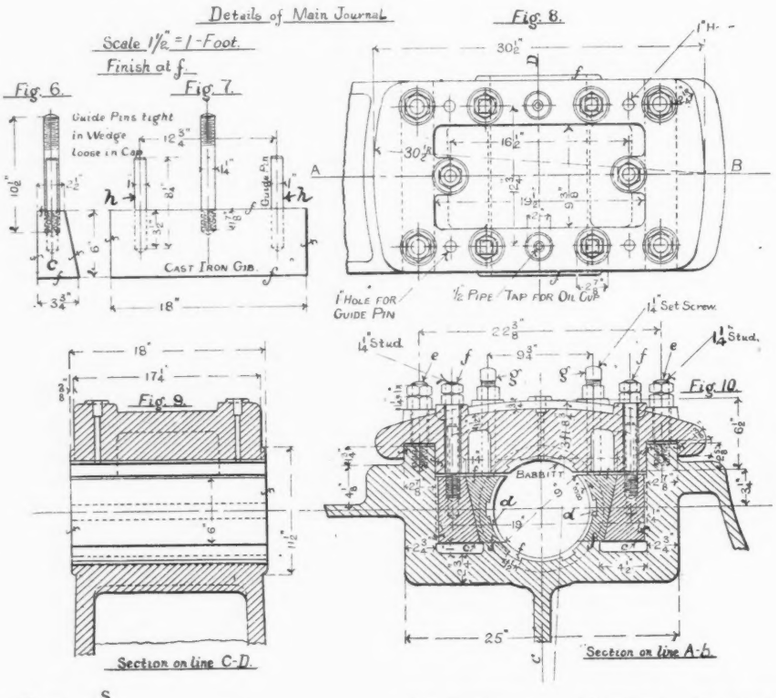
Let S=total steam pressure on piston in pounds.

Let n=ratio of length of connecting-rod to crank.

Our connecting-rod, is 72 inches long, crank 12 inches, and dividing 72 by 12, gives:

n=6. S=25125.

Let S_1=upward pressure on cap in pounds.



$$S_1=\frac{S}{\sqrt{n^2-1}}$$

n, squared=6×6=36, minus 1=35, extracting square root gives us 5.91 approximately. Therefore,

$$S_1=\frac{25125}{\sqrt{36-1}}=4251.2$$

pounds for upward thrust on pillow-block cap. These only take in the force of total pressure on piston, and when engine is running over, as illustrated in Fig. 11 (from the angularity of connecting-rod), an allowance must be made for any extra forces; if, for instance, we connect a gear to main shaft on a horizontal plane, and drive it in one direction, the same as the arrow points, we will add to the pressure already found. It will be advisable to add at least 100 per cent. to our first calculation, which gives 8502.4 as the maximum pressure on under side of cap. As we have four pillow-block studs, we divide 8502.4 by 4, which gives 2125.6 pounds pressure on each stud, which should be large enough at bottom of thread to resist this pressure. These studs should not have over 3,000 pounds pressure per square inch of area, and dividing 2125.6 by 3,000 gives .708 as the required area of stud at bottom of thread, which in practice would be called .7854 area, or 1 inch in diameter at bottom of thread, giving a stud 1¼ inches outside diameter. The journal should be lubricated with two ½-inch oil cups, one on each side of journal box, with body of cup about 2¼ inches outside diameter and 2½ inches high. There should be a number of spiral grooves, cut directly on the wearing surface of the babbitt metal, both in cap and bed part of journal, also in the gibs *d d*, for perfect lubrication. It will be noticed in Fig. 10 that the gibs *d d* are made very heavy, being 2 inches thick at the weakest point; it is customary to make this thickness a little less than one-quarter the diameter of the shaft. The total height of gibs should be two-thirds the diameter of shaft, which gives 6 inches exactly. The thickness of wedge at top should be double the diameter of adjusting stud f, or 2½ inches. The wedge should be tapered 2½ inches to the foot for best results. The projected area of journal is the length multiplied by diameter, which in this case is 18×9=162 square inches of projected area. The pressure per square inch should not exceed 400 pounds for babbitt metal; when greater pressure is desired it is better to use phosphor bronze. As the maximum pressure on journal is 25,125 pounds, dividing by 162 gives 155 pounds, the exact pressure on each square inch of projected area. A journal with this small pressure should not heat to any extent. This design of journal will give the best results under ordinary conditions, as every part is heavy and capable of sustaining its share of pressure, the cap is lipped over the end of bed, binding them, and forming a complete lock when under pressure.

THE CYLINDER.

This, with its necessary valve motion, is the most difficult part to design, as the ult i mate economy of the whole engine lies here. The steam and exhaust ports should be calculated with great care for the required piston speed in feet per minute, so as not to have too much or too little clearance. Most cylinders have too much clearance for good economy, there being a great diversity of opinion among steam engine designers on this subject. The cylinder should have the steam and exhaust valves in close proximity to the bore, as this allows the clearance to be reduced to less than 3 per cent. of the piston displacement, if desired. To obtain the best results in practice it is not advisable to go below 3 per cent. when the cylinder length is twice the diameter. The clearance space objected to by many designers, proves, when properly filled with exhaust steam, by compression, to be a source of economy, and affords a sufficiently gradual cushioning action. The compression has also an important economical effect of lessening the condensation of the incoming steam. The cylinder should be made of hard cast iron, to stand the wear of the piston and valves, but at the same time, should be soft enough so that it can be bored perfectly cylindrical, the ends faced off, bolt-holes drilled, valve-seats planed smooth, and the exhaust valve holes bored perfectly true.

We decided on four expansions of steam as being the most economical point of cut-off, and one-half cut-off, for the latest point advisable in cylinder for smooth running and good regulation; although to attain this the valve motion should be designed so it can cut off at about ⅝ of stroke. This is advised in order that the governor weights may be working within the limit of their extreme travel, and will also relieve the governor springs, by keeping the distance between coils within the elastic limit.

Before illustrating the cylinder it will be well to give the general specifications, which will be readily understood in connection with the cylinder drawing. Area of steam port, 19.49 square inches, .097 per cent of piston area, based on ten per cent. for 700

* The calculation of shaft will be taken up in a later article.

feet piston speed per minute. Area of exhaust port, 21.1 square inches, or about .08 per cent. more than area of steam port. Area of steam-pipe, 28.61 square inches, based on 80 feet mean velocity of steam per second; at this rate the loss of pressure between boiler and cylinder steam chest is comparatively small. Area of exhaust pipe, to give the best results, should be approximately 35 per cent. larger in area than the steam pipe, causing a minimum amount of back pressure. Length of steam port, 12 inches; width, $2\frac{5}{16}$ inches at valve seat, tapering to $1\frac{5}{8}$ where port enters cylinders; this allows for a double admission of steam, giving a higher initial pressure than could be obtained with only a single admission. Length of exhaust port, 12 inches; width, $1\frac{7}{8}$ inches; with a small rib in center, $\frac{3}{4}\times1\frac{7}{8}$ inches; this rib is placed in the port to keep the cylinder from spreading in the center, also to allow the piston ring to slide over the port and not drop into it when placing the piston in cylinder. Diameter of exhaust valve is 5 inches. The illustration of cylinder will be given in the next article of this series, with all the necessary information for designing and calculating.

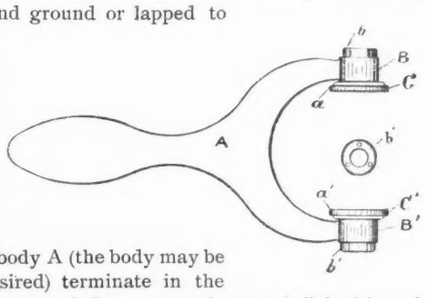
* * *

A FEW SHOP KINKS.*

JOHN T. USHER.

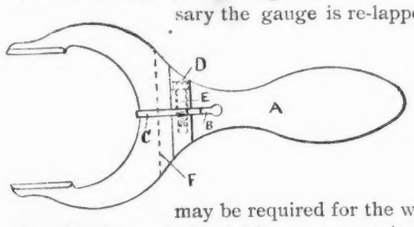
SNAP GAUGES FOR STANDARD MEASUREMENTS.

The absolute necessity of some arrangement for compensating for the wear of the various tools employed in machine shop practice has engaged the attention of the machinists in all branches of the profession. But snap gauges appear to be an exception to this rule, no provision whatever being made for this purpose in general practice, or in any instrument now on the market, and consequently when such adjustment is necessary the gauge must in most cases be annealed and closed or expanded, and then rehardened and ground or lapped to size.



The engraving shows side elevation of an adjustable snap gauge, which is easy to maintain at or restore to the given standard.

The arms of the body A (the body may be of any pattern desired) terminate in the form of hubs; these hubs B B′ are bored out parallel with each other and faced off on both ends of the hubs. The jaws C C′ which form the measuring terminals are turned and hardened and inserted in the hubs B B′. The flanges *a a*′ are made either round or square as preferred. As the jaws may be sprung somewhat in hardening, a slight allowance is made for grinding or lapping the gauge to size after they are inserted in the hubs. The collar nut *b*′ *b*′ *b*″ is made preferably round, with holes drilled therein for a pin or spanner wrench to prevent any possibility of the gauge being tampered with. When it is necessary to adjust the gauge for wear very thin metallic or paper washers are inserted between the flange C A and the hub B, and if necessary the gauge is re-lapped or ground to size.



This instrument can be used for different sizes by inserting jaws of such thickness as to reduce the gauge to any size that may be required for the work in hand.

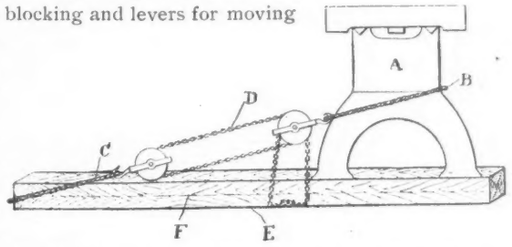
Another form of adjustable snap gauge is shown in the second illustration. The body A (which is of an ordinary pattern) is slotted at B to receive the distance piece or liner C, and drilled and tapped at D for the binding screw E. When the slot B has been cut the jaws are sprung apart somewhat to create a continual tendency to close together, and the liner C is fitted closely in the slot B, while the jaws are in this position, after which the liner is hardened and inserted in the slot and the binding screw tightened up. The jaws are then ground and lapped to size.

* Copyrighted, 1894 by John T. Usher.

To adjust the gauge for wear the liner is taken out of the slot and reduced in thickness as much as required; it is then replaced and if necessary the jaws are re-lapped to size.

MOVING HEAVY MACHINERY.

The transportation or moving of heavy machinery to their places on the foundations is often a matter of some difficulty. Skids and rollers are always utilized when they are available, but as a general thing they can only be used for moving the machinery in one direction, and resort must be had to blocking and levers for moving the machinery in a lateral or transverse direction onto the foundation, which is not only a slow and tedious process, but also expensive.

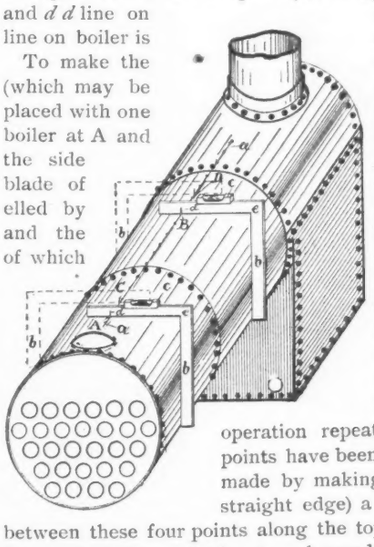


The method of moving heavy machinery shown in the illustration has proved very successful in our own practice, and we can recommend it for moving heavy machinery very quickly in any direction.

The plan consists in placing a plank or beam of wood under the feet or frame of the machine facing the direction the machine has to be moved, and then attaching a sling around the machine and another sling over the extreme end of the plank or beam, and then connecting the two slings by means of a tackle block, as shown at B C D in the engraving, where A represents the extreme end of the planer bed and platen, B sling around the standard of the same, C sling across the end of the plank E upon which the planer rests, D tackle block which connects the slings B and C. When moving a machine in a transverse direction a tackle block may be used on each end of the machine, so that each end may be moved in unison, and when moving the machine in the direction of its length, either one or two tackles may be used; if one is used, a bar should be placed across the extreme ends of the planks, and the tackle block hooked on to that. The only thing necessary to be observed in using this appliance is to get the sling on the machine as low as compatible with safety to the machine legs, and to get the sling on the end of the plank below the medium line F of the plank, to prevent the latter from raising.

LOCATING A CENTER LINE.

A center line is to be made on the top of the boiler parallel to the longitudinal axis of the same by means of a square and level, as shown in the illustration, where *a a* represent the center line on top of boiler, *b b b b* square (including dotted lines), *c c* level, and *d d* line on square from which the line on boiler is obtained.



To make the center line, a square (which may be either wood or steel) is placed with one blade resting on top of boiler at A and the other blade touching the side of the same. The upper blade of the square is then levelled by means of a spirit level, and the line *d* (the distance of which from *e* to *d* should be equal to the radius of the outer diameter of the boiler) transferred to the boiler. The square is then transferred to B C D in succession and the operation repeated. When these four points have been made, the center line is made by making and continuing (with a straight edge) a line directly through or between these four points along the top of the boiler from the fore end of the smoke box to or beyond the dome.

This same principle can be readily applied to any cylindrical body, and will be found exceedingly useful in many cases.

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NOVEMBER, 1894.

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* * *

"WRITE-UPS."

Some intending advertisers have asked us how many "write-ups" we could give them during the year, and our answer was that—as the term is understood—we could give them none. The policy of MACHINERY is not to insert any reading matter that has ever been published in this country, with the single exception of "Manufacturing Notes," under which head we propose to concisely describe new catalogues and matters of interest to our advertisers and the trade generally.

Any advertiser who stops to consider the question will at once see that this rule is for his direct benefit as well as for the good of the paper, because the very first requisite of an advertising medium is that it shall be READ; and who reads "write-up" papers? Nobody.

"Write-ups" are the curse of trade journalism, for they never contain any news and seldom any information. They are impositions on the good faith and good nature of the men who buy the paper for news, and they are tokens of dry rot wherever they appear. Beware of papers that are liberal with "write-ups. Space in them is of little value or it wouldn't be given away.

* * *

LEARNING A TRADE TO FALL BACK ON.

"I haven't quite made up my mind whether I would rather be a machinist or a lawyer."

Such was the reply of a youth who had applied for a position as apprentice in a machine shop, to the proprietor, who was questioning the youth as to his tastes, and what his reasons were for wishing to learn the machinists' trade. It is hardly necessary to say that the youth did not get the position.

This youth had no doubt been advised by some well meaning, but mistaken friend, to "learn a trade to fall back on;" in other words, if after some years of experimenting as a lawyer, he should turn out a failure, he could then "fall back on his trade," and be a good enough machinist.

This idea would be amusing if it were not so exasperating: just as though the machinists' trade, of all others, were standing still, while everything else in the world progressed! It is not necessary to say that the trade that allows the world to enjoy the application of the discoveries of science, that makes it possible to go from New York to Chicago in a day, or to Europe in five days, to ride in cars propelled, lighted and heated by an unseen force, and to photograph the stars, has done the world more good than all the lawyers; and no lawyer need consider it a disgrace to "fall back on the machinists' trade," if such a thing were possible, but fortunately it is not possible, and the man who had been trying to become a lawyer, and should then try to make a living by "falling back on his trade," would find that he had more to learn than the greenest apprentice boy that ever entered the shop, and practically no one would give him a job any way.

Don't "learn the trade" unless you are fitted by nature for it, and if you are fitted for it don't hesitate to learn it; no occupation is more honorable, and if you go into it, go into it *honestly*, not forgetting that "the talent for success is nothing more than doing what you can do, *well*, without a thought of fame."

* * *

WHAT MECHANICS WANT.

If our experience in the shop has been read aright, it is that shop-men need and must have their information in as concise a form as possible. And further, the mechanic has little time to spend in reading of matters not directly pertaining to his trade, although all branches of that trade must receive some attention. Mechanics want to know what other men are doing, of new tools for special work, devices for helping out some hard job, and they want these thoroughly illustrated and concisely explained, in fact the old maxim may be changed to "Drawings speak louder than words" It is the same with engineers. The best current practice is what interests them, and while it is interesting and instructive to read of past failures and successes, the paper that is demanded must be fresh, concise and have the information desired. What men *have done* is recorded in books which can be consulted in the libraries, but what men *are doing* should be the main consideration of a trade paper, interspersed with such matters of history as point to better methods of working.

FORCED vs. NATURAL (?) DRAFT.

PETER H. BULLOCK.

Of all the separate things that relate to the erection and economical management of steam plants, perhaps there are none about which there is so wide a difference of opinion as on the subject of draft for producing the satisfactory combustion of fuel.

Mr. Le Van goes on record as thinking forced draft a mistake, and argues in favor of chimneys of sufficient height and area to produce the requisite draft for boilers. All cases and problems, however, have more than one side to be looked into, and like mountains they very often look different when viewed from different standpoints. If conditions were always the same as to surroundings, quality and price of fuel, permanency of location and amount of capital available to invest in a manufacturing establishment, it would be quite easy to scientifically determine which method it would be best to adopt in order to successfully do very many of the things about which we are often in doubt, and about which the best informed men disagree.

Regarding the subject from a sanitary point of view there can be but one opinion as to the desirability of delivering the gaseous products of combustion at as high an altitude as possible so that they may become rarefied to such an extent as to be harmless and unnoticeable to any who may live or work in the vicinity. Besides, it is not to be supposed that any one who might equip a boiler plant with any kind of forced draft would be inclined or allowed to construct it in such a way that its operation would be injurious to the health of operatives or inhabitants.

As to the claim that there is always an upward draft in chimneys regardless of the presence of heat, I am not willing to admit, although in a majority of cases it is so, especially if there is any wind blowing and most persons know there is very seldom a time when there is not some movement of the air. Of course the draft induced by the action of the wind is as well understood as is that produced by the ascension of the column of heated gas and infiltered air that make up the volume of a chimney when carrying away the products of combustion from the furnaces of a boiler plant. Given for instance a chimney of any reasonable height, and in which there is absolutely no heat, and a day when there is absolutely no wind, and it will be found impossible to detect any ascending current in the flue. Were it otherwise a service of perpetual motion would be at our disposal. On the contrary, if the chimney base happens to be in a building considerably sheltered, and the temperature happens to be lower than outside, there may be found a descending current into the cooler space below.

One of the advantages of forced draft is the fact that it can be run to exactly suit permanent conditions of location and the variable demand for steam regardless of the conditions of wind or weather. This flexibility of draft makes it possible for the intelligent engineer to find out by comparison what rate of combustion is the most economical for his particular plant, and what quality of coal the best to use. It permits him to control the vital principle of combustion and to take advantage of all the information he thus requires. Where the draft is produced by a chimney, its maximum capacity is a fixed factor dependent upon its height, area and temperature, but modified by the velocity of the wind at all times, and occasionally by its direction, as when other structures induce deflecting currents either at its top or base.

Forced, as artificial draft is usually interpreted, means that produced by any other means except a chimney; but to be accurate a chimney is as much a means of artificial draft as any other method, and often more costly to operate than many others. With this absence of distinction in principle fully in view, it is then in order for any one who proposes to erect a steam plant to choose any of the methods that are available, keeping in mind the first cost, cost of maintenance and probable economy of operation.

Regarding the different means of producing draft other than by area and elevation of stack, the one most usually adopted for stationary purposes is either by forcing air through the fire by a closed ash pit, or by exhausting the gaseous products of combustion from the up-take after they have passed the heating surface of the boiler. In either method the results are substantially the same so far as the temperature of the escaping gases are concerned, for in the first case they are forced forward by continual displacement as more air is forced through the fire, and in the other they are sucked away and the space filled by air that forces itself through the fire to replace that exhausted, the comparative temperature at the up-take being of little consequence in either case so far as the movement of the volume is concerned. And right here is where the forced draft may get in its economical work, from the fact that the heat should be absorbed by the boiler or economizer nearly to the temperature due to the steam pressure carried, or far below it if an economizer is used, while in the case of a chimney the temperature must be high enough to produce the necessary draft, or usually about 600 degrees. Now if the heat between these limits is turned into energy and that energy is more than sufficient to mechanically produce the necessary draft, the difference must represent the economy of the operation as the saving in using a forced over a so-called natural draft, or chimney.

Much has been written regarding the loss due to leaks through cracks in the brickwork and connections of boilers, and also through the porosity of the brickwork itself. That such leaks do exist cannot be denied, but the amount due to porosity or to air going directly through the bricks and mortar, can be put down as a very small per cent., owing to the small difference in pressure between the flue and the outside, but cracks in brickwork and around flue connections are pretty sure to be in evidence and are a direct loss in every case. The different methods of forced draft will also affect these leaks differently, as for instance, if the air is forced under the grates the leakage may be from the furnace and connections outward, and besides the loss of heat the gases may be unpleasant, as well as injurious to health. If the draft is produced by suction in the up-take the result is the same as in the case of a chimney.

There are several little things to be thought of and which have their bearings both for and against forced draft, not only in the first construction, but in the subsequent operation of them. I will note a few: Regarding a chimney, it may be said that its cost and capacity can be very accurately figured, and that when once properly erected there need be no further thought given it except to charge interest on its first cost. Its cost of operation, however, as before noted, may be quite a figure. Where mechanical draft is wholly depended upon the plant is comparatively helpless until there is sufficient steam to set the apparatus in motion. Where air is forced under the grates it is usually necessary to close off the supply when the furnace doors are opened. There will also be more soot and fine ashes deposited in the tubes and connections than when the gases are exhausted. Of the two systems it is my opinion that unless some peculiar conditions exist, that exhausting is the preferable one to adopt.

The writer's first experience with the subject was the burning of tan-bark screenings and soft coal, using a blower to force air under the grates; and next after that, and now more than twenty years ago, was with an apparatus fitted up to exploit a boiler designed by a man who thought himself an inventor and who was about to revolutionize mechanical matters in general The boiler was a failure, but the means for exhausting the gases worked to perfection, and was substantially the same method as now generally adopted for the same purpose. The fan was run by a small engine arranged to run at any speed necessary to meet the varying conditions, but in a properly designed plant the speed of the fan should be governed by the steam pressure acting through suitable attachments to a sensitive damper regulating machine.

Chimneys will never be replaced by other methods, but the use of mechanical draft if bound to increase as its advantages become better known.

PECULIAR ACCIDENT TO A LOCOMOTIVE BOILER.

The illustration shows the results of the failure of a locomotive fire-box on a passenger engine. The train to which the engine was attached was just coming to a stop at the time of the accident; and was therefore at a greatly reduced speed. The failure was due to the fracturing, or perhaps we might say shearing, of the crown-sheet directly across the fire-box, at the edge of the flange of the tube plate. The free end of the crown-sheet sprung down and threw so great a strain upon the braces in close proximity as to cause failure, and the accumulated leverage completed the wreck by breaking the braces and stay-bolts, tearing loose one side plate and forcing it across the fire-box, folding back upon itself one-half the crown-plate. No portion of the plates of the fire-box were broken off or blown away, but caught the brick arch and ground it to atoms between the uninjured leg and the ruptured sheet. The force of the escaping steam and water was sufficient to lift the drivers from the track, breaking the engine loose from the tender. The length of the ruptured plate was sufficient to reach below the fire-box, this giving direction to the escaping steam and water, the force of which drove the engine in the opposite direction, the forward truck-frame and king-bolt acting as a pivot to the forward end The engine

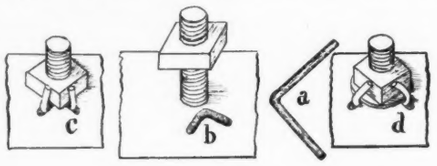
was turned completely around and nearly replaced on the track, but the force was so far spent that the drivers came in contact with the rail, bending the axle and breaking the rail. So quickly was the engine turned around that the pilot caught the tender attached to the moving train and turned both engine and tender over, but did not derail or wreck any car of the train. Both the engineer and fireman were blown from the cab and instantly killed. Investigation showed the fracture to be new, and no defect in the plate was noticed except the appearance of extreme hardness of the metal. Specimens cut out and tested disclosed the fact that the tensile strength of the plate was about 87,000 lbs. per inch, and having very little ductility. Such plate is unreliable and should never be used in boiler work, or even in any structural work having strains liable to cause failure. As the point of fracture was a rigid one when the plate was connected with the tube-sheet, undoubtedly the strains were localized near this point, and the plate having low ductility soon suffered from fatigue, and failure occured. Had coupons from the plate been subjected to tensile and physical test previous to working the plate its true character would have been discovered and should have condemned its use. The present practice in all the best manufacturing establishments is to subject coupons from each plate used to rigid test, and reject all plates not coming up to the requisite standard of ductility and strength, it being impossible to get steel plates of extremely high tensile strength without a proportionate loss in ductility.

* * *

HINTS FOR MACHINISTS AND ENGINEERS.

JAMES F. HOBART.

NUT locks innumerable have been designed for preventing nuts from becoming unscrewed, and many patented devices are on the market. For the purpose of temporarily or permanently "locking" a nut on a machine, whether screwed down upon iron or wood, I know of nothing better than the bent wire shown at *a*, Fig. 1. About No. 8 iron wire (hard drawn) works well for bolts from one-half to one inch in diameter, smaller or larger wire should be used for locking nuts on bolts below and above the sizes given, according to judgment.

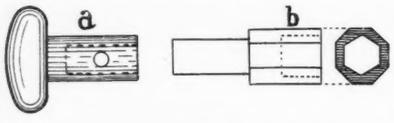


With a very narrow sharp cold chisel, cut a channel as shown at *b*. The groove should be only just large enough to admit the wire, and if so snug a fit is secured that the wire cannot be moved, so much the better. Be sure to cut a groove with an angle in it as shown, because this part of the business is what keeps the wire from turning around when the attempt is made to bend the ends up against the nut as shown at *c*.

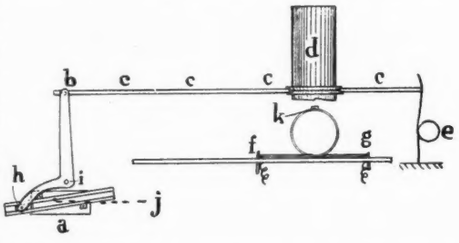
If the groove is a snug fit for the wire, and the angle is made as shown, there will be no difficulty in bending up the wire, as shown at *c*. The nut thus locked is not held as firmly as by some nut-locks, but it will effectually prevent all unscrewing of a nut by jarring, and allows a nut to be removed at will, by a slight twist with a wrench. The wire bends right out of the way, and becomes useless for future use, but wire is cheap, and a new piece is readily put in.

When the bolt is to be locked upon a wooden frame or surface, the wire may be bent as at *a*, then simply slipped under the washer, and the nut screwed home. After that the ends may be bent up, reaching over the washer, as shown by *d*.

THE ratchet-drill stock makes a first-class wrench for certain kinds of work, socket business especially, and by putting on a kind of inch bit-stock head like that shown by *a* (Fig. 2) and putting a socket like *b* in the drill-hole, a wrench is formed which will work in pretty close quarters without jambing knuckles or having to be bent to fit the job in hand.



A FORM of indicator reducing motion is shown by Fig. 3, which is positive, and does not depend upon "lazy tongs," pantograph movements, or reducing pulleys for the movement of the drum, neither is a cord used which may change its length with each degree of temperature or humidity. The slotted guide *a* is fastened to the cross-head by bolts on set screws, and the amount of movement imparted to the rocker-arm by the sliding block *h* is regulated by the amount of angularity given to the slotted guide.



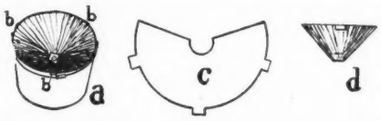
The fulcrum of the rocker-arm is shown at *i* for the sake of clearness in the engraving, but it should be located, in practice, somewhere in the dotted line *j*, in order to have a minimum angularity error effect upon the travel of drum. The vertical arm *b* should also stand perpendicular at mid-stroke of cross-head.

Instead of a cord a small stick is used, supported if necessary by the shears at *c c c*. A hardwood stick very small in section may thus be used without danger of it springing or buckling. A spring, *e*, stiff enough to take up all possible lost motion, is added to assist the rod. Usually the indicator spring is sufficient to do this, and spring *e* may be omitted, but in very short stroke, high-speed engines a light drum spring, supplemented by a light spring at *c*, will be found better than a heavy drum-spring.

The method of attaching indicator-drum to the reciprocating stick is shown at *f* and *g*, which are two small wedges driven into little holes in the wooden rod, through which has been passed a piece of catgut or soft wire twine, which has been coiled around the indicator-drum and made fast thereto at *k*. The de-

vice much resembles the old-fashioned fiddle-bow drill, so much in use even at this day, by old-time mechanics and jewellers.

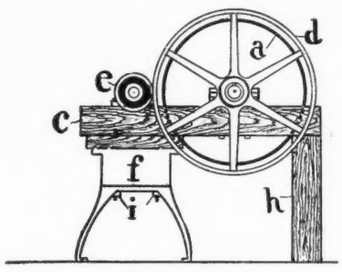
A FIRST-RATE oil collector for the vertical drill press and for some other machines is illustrated Fig. 4. It consists of an ordinary iron pail (*a*), into which a strainer is fitted, the latter being held by their lugs *b b b*. The method of constructing strainer is shown at *c*. A piece of heavy tin, or galvanized iron, is cut as shown, the radii being 1¼ and 9 inches respectively. A segment of 140 degrees is cut out, leaving the piece shaped as in the engraving. The edges are brought together and soldered, or riveted, and a piece of fine wire cloth is fastened (soldered), as shown by the dotted line in *d*.



The wire cloth may be omitted and a bit of waste stuffed into the hole in bottom of funnel. A little oil is lost by being absorbed in the waste, but what oil remains is cleaner than when the wire strainer is used. The cone is put into the pail and is supported by the lips, as shown, the upper edge of strainer being made large enough to completely fill the pail, so no dirt can get into the oil which collects in bottom, leaving the iron cuttings in the conical dish above. The measurements given above are for a funnel to go into an ordinary water pail, 11 inches in diameter (at the top) and 8 inches deep. The cone then bends up 11 inches in diameter and 6 inches high, with a 1½-inch hole in small end.

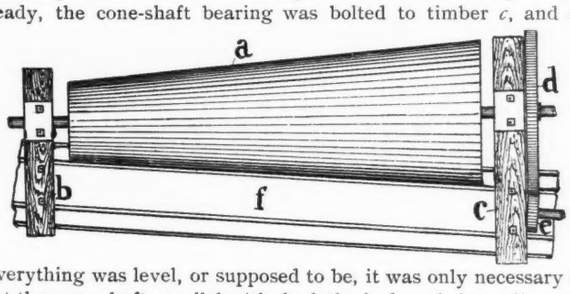
TURNING a 10-foot cone pulley, 41 and 21 inches in diameter, in a 17-inch lathe, without blocking up head or tail-stock, is a job which seemingly calls for a considerable rigging up, but really the matter is much more simple than it appears to be.

Figs. 5 and 6 give a good idea of the rigging used. The shaft on which the cone was keyed was about 17 feet long, so there was plenty of room on the shaft at either end of the cone. A pair of spur gears were the first to be hunted up, and these had to be big enough (in diameter) to reach from the lathe spindle to the cone shaft, when the latter was set back far enough so the big end of the cone would run free of lathe bed.



A 48 and a 10-inch gear were found which would work fairly well, and these were used to do the job with. Four sticks of timber 8 by 8 inches were cut up and disposed of, as shown in the engravings at *b* and *c*, Fig. 5, and *c* and *k*, Fig. 6. Timbers *b* and *c* were blocked up, so as to bring the center line of cone shaft level with center of spindle. The large gear was keyed to cone shaft, and small gear bolted to lathe face plate. These gears are not in line with each other, as shown by Fig. 5, but they run well enough for a short job.

The timbers *b* and *c* are bolted to the lathe-bed *f* at one end of each timber; the other end of each projecting to be supported by the posts *h* (similar parts are lettered alike in both Fig. 5 and Fig. 6), and braced with strips of board not shown in the illustration. Gear *e* is bolted to lathe face-plate, or it may be put upon a short piece of shaft, and held by a chuck. In making the job ready, the cone-shaft bearing was bolted to timber *c*, and so



everything was level, or supposed to be, it was only necessary to set the cone shaft parallel with the lathe-bed, and then adjust the tool exactly level with center of spindle.

* * *

A CUBIC inch of cast iron weighs .26 of a pound, but for making estimates is usually called .25. By dividing the number of cubic inches in a casting by 4 we have the weight in pounds.

THE SLIDE RULE IN THE SHOP.

WILLIAM COX.

Although the general appearance of the modern slide rule, such as the Mannheim, which is the best and the one most frequently employed in this country, is well known to most readers of MACHINERY, a few introductory explanations will not be out of place before we turn to the consideration of a few practical problems relating to our noble craft.

The slide rule, apart from its mechanical details, consists of four decimally graduated scales, two on the rule and two on the slide, so placed side by side that they may be compared together in pairs. These scales are, for convenience, called A, B, C and D, A being on the top of the rule with D at the bottom, while B is on the top edge of the slide and C on the bottom edge; the pairs, which are divided exactly alike, and can be compared together, being consequently A and B at the top and C and D at the bottom. The scales which interest us most for the purposes of ordinary calculations and to which the following remarks specially refer, are C and D, which are numbered in bold figures from left to right 1, 2, 3, 4, etc. The space between any two consecutive figures is subdivided into ten parts, each of these parts being again further subdivided into halves, fifths or tenths, according as the space allows. The space from the left 1, or *index*, as it is called, being much larger than that between any other two consecutive figures, the first subdivision, or tenths, are also numbered, but with small figures, and each of these tenths is again subdivided into ten parts, making hundredths of the whole space from 1 to 2.

It must now be clearly understood that these figures are *purely and simply* FIGURES and *not numbers*, as they and their subdivisions possess no value whatever of their own, but only such values as are attributed to them when the solution of any problem is undertaken. Thus, *figure* 1 may stand for the *numbers* 1, 10, 100, 0.1, 0.01, etc., and whatever value we may attach to the left index 1, a corresponding value belongs to *all* the other figures, so that the values of the figure 4 corresponding to the above index values would be 4, 40, 400, 0.4, 0.04, etc. This attribution of values to the figures is the reason why the left 1 is called the *left index*, and the right 1 (not 10) the *right index*. Now, if in a given problem the first number we have to deal with should be 5,000, we take 5 on the scale C or D to represent this amount (the figure 5 thus becoming equivalent to the number 5,000 or 5×1,000), then the left index will have the corresponding value of 1,000, while the corresponding value of the right index would be 10,000, all intermediate figures having values 1,000 times greater than their face values.

The primary subdivisions would now have values 100 times greater than their face values, and the secondary ones 50, 20 or 10 times greater, according as they are halves, fifths or tenths of the primary subdivisions. Thus the value of the first *full* line to the right of 5 would be equal to 5,100, and that of the first *short* line would be 5,050. A little careful study of these decimal subdivisions of the main spaces, and of the principle of primarily attaching a value to any given figure or to the indices, will soon enable any one to "read" the value of any graduation, or conversely, to find the graduation corresponding to any given number.

This is the first point in connection with the slide rule which requires to be thoroughly mastered, and I have entered into it somewhat at length because I have often found it to be a stumbling block and a hindrance to the further study of this ingenious and valuable instrument. Every feature of the slide rule, as also its manipulation, are, however, found to be so simple when the beginner "catches on" to this and the following principle, that I cannot but urge him to persevere and, above all, to follow the order here laid down, otherwise he may find himself landed in the slough of despondency.

Our next and last principle is this: *Place the slide as we will, all the coinciding graduations of the slide and the rule form a series of* EQUAL RATIOS. We have said that the scales C and D are graduated and figured alike, so that if we make the indices coincide, then the graduations figured 2, 3, 4, etc., with all the subdivisions, will also coincide. If we now push the slide to the right so that its left index coincides with 2 of the rule, we have the ratio 1 : 2. Following to the right we find in consecutive order the ratios 2 : 4, 3 : 6, 4 : 8, 5 : 10, all of which are equal to the ratio 1 : 2. If we now give to the left indices of scales C and D the

values of 10, so that the primary subdivisions will have the values of 1, 2, 3, etc., then we begin at the left of the slide with the ratio 10: 20, and proceeding to the right find 20: 40, 30: 60, etc. Taking now the primary subdivisions we find 11: 22, 12: 24, 13: 26, 21: 42, 35: 70, and so on, all these ratios being equal to the one simple one, 1: 2.

If, assuming the same value of 10 of the left indices, we now place the left index of the slide "over," or coinciding with 21 of the rule (the first primary subdivision between the full figures 2 and 3) we have the initial ratio 10 : 21, and we find on looking towards the right the following coinciding pairs of graduations: 20: 42, 30: 63, 40: 84, also 15: 31.5, 25: 52.5, 35: 73.5, etc., whilst it will be clearly seen from what has been stated that if we assign a value of 1 to each of the left indices instead of 10, we have the ratios 1 : 2.1 2 : 4.2, 3 : 6.3, 4 : 8.4, also 1.5 : 3.15, 2.5 : 5.25, etc.

This brings us to the simple rule for MULTIPLICATION, which many readers have probably discovered, for multiplication is nothing less than proportion, or an equality of ratios. Thus, $2\times4=8$ is the same as the proportion $1 : 2=4 : 8$, to work out which on the slide rule we set off the initial ratio 1 : 2 by bringing the left index of the slide over 2 of the rule, then under 4 on the slide we find 8 on the rule, which is the product of 2 and 4. The rule is, therefore, *Set the index of the slide to either of the factors on the rule; then below the other factor on the slide find the product on the rule.* This is generally expressed thus:

Scale C..	Set 1	Under other factor
Scale D..	To the factor	Find product.

DIVISION is also a simple proportion, but in reversed order to the foregoing, thus $8\div4=2$ is the same as 8: 4=2: 1, and the rule for working out becomes. *Set the divisor on the slide over the dividend on the rule; then below the index on the slide find the quotient on the rule*, or

C.....	Set divisor	Under index or 1
D.....	To dividend.	Find quotient.

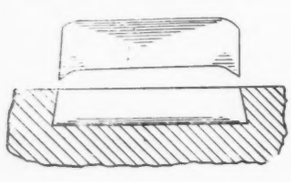
A point which sometimes puzzles is the following: Suppose we first set off the ratio 1 : 2, 1 being on the slide or coinciding with 2 on the rule. If we now follow the slide until we get to the figure 6, we find no corresponding figure beneath it on the rule. We have therefore to bring the slide back until the right index is over 2 on the rule, then continuing leftwards on the slide till we get to 6, we find it over the second primary division between 1 and 2 on the rule, which is equivalent to the figures 12. What is, however, the numerical value of these figures—is it 12 or 1 2? Of course common sense says 12; but why? Because we at the outset gave to the left indices the value of 1, and consequently to the right indices the value of 10. By bringing the slide leftwards we change the value of the left index of the rule, giving it that of the original right index, or 10, just as if the scale D of the rule had been repeated to the right of its right index. The left index of the rule having now the newly assigned value of 10, the value of the second primary subdivision is consequently 12, which is the value of 2×6, or the fourth term of the proportion 1: 2=6: 12.

From this we deduce the following rule for the number of integral figures in any product: When the slide projects to the right, the number of integral figures in the product is equal to the sum less one of the integers in the two factors; and when the slide projects to the left, it is equal to the sum of the integers in he two factors. For division this rule is reversed.

* * *

A PATCHING-UP JOB.

The writer once touched the heart of one of his old foremen by chipping out a bad spot in a polished crosshead and putting in a small piece of the same kind of iron, fitting it so closely that it could hardly be detected even by close inspection. It was nothing new for me, having been used to a similar class of work (setting in, not patching), gunsmithing, and so when the foreman was lamenting the appearance of that spot. I suggested that we take it out. "If you can do it, go ahead," was the reply, and it may interest some of the younger mechanics to know how this is done. The cut will show about all there is to it, the spot being cut out with a sharp chisel and a recess cut as shown, with all the sides undercut so as to hold the piece when in place. Then from a bar of the same iron, with the grain running the same way, cut out a piece which is fully as large as the bottom of the recess cut, and after putting about the same bevel on the sides, they must be hammered down (or the center of the piece bumped up), till the piece will just drop into place, when careful hammering at the center and edges will fit it into place tightly and securely, and the extra thickness (for this must be allowed in all cases), the hammer-marks, etc., can be removed in any way that is handy—chipping, filing, or planing. This can be used for fastening uprights in any piece of metal, and will be a strong job if carefully done, and there are other applications which are useful, as well as patching up bad spots in the metal.



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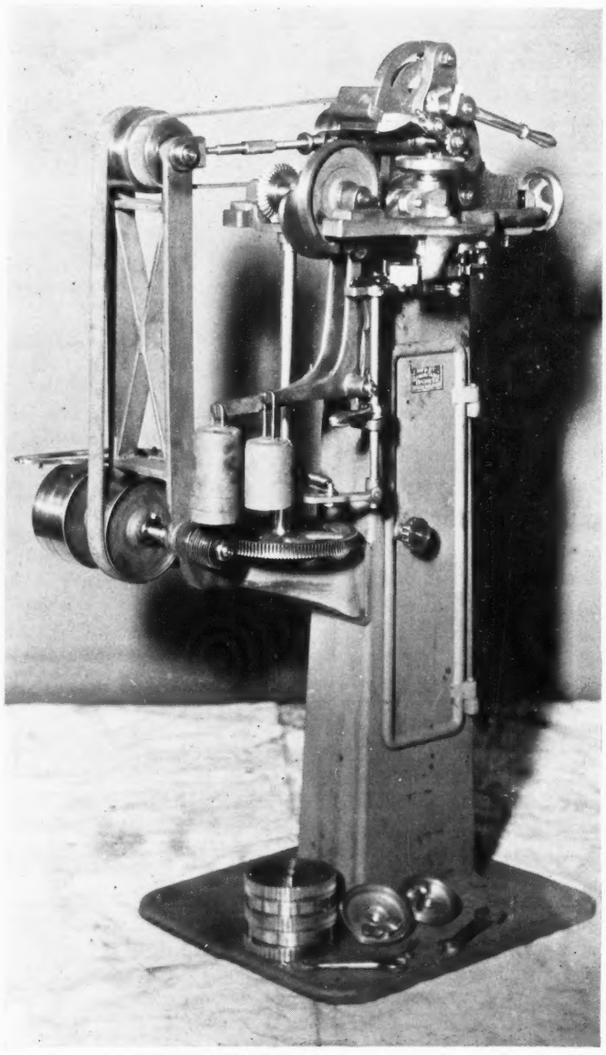
AN AUTOMATIC BEVEL GEAR AND PINION CUTTER.



This machine is designed to cut bevel gears 6 inches in diameter and smaller. The head carrying the cutter arbor is pivoted and provided with a graduated scale for ready adjustment. The spindle on which work holding fixture is attached has a positive double movement. On the lower end of this shaft an index gear is placed and adjustable indexing mechanism provided by means of which any number of teeth greater than seven can be cut. An automatic trip is provided, so that when the last tooth of any gear is cut the feed will drop out. The second movement of this spindle is that of elevation. After the cutter has passed through the work, the work holding arbor lowers, and the cutter returns to its first position without contact with work. The work arbor is now indexed to proper position for the next tooth and raised to give desired depth of cut.

The machine is at present made in but one size, by the Dwight Slate Machine Co., Hartford, Conn.

BOILER ROOM ACCIDENTS.

W. H. WAKEMAN.

Comparatively few accidents in boiler-rooms are caused by gross ignorance on the part of the operator, but they are much more often due to a disregard of well-known principles on account of great haste in effecting changes, cleaning boilers, or making repairs. It is to these we refer, hoping that it will prove beneficial to our readers.

A fireman while cleaning one of his boilers allowed the water to run out of it, then filled it with cold water, allowed this to run out, and immediately took off the nut which held the man hole cover in place in the lower part of the head. The cover remaining in position after the nut was removed, he took hold of the rings provided for loosening it and attempted to shake it, when the cover flew inward with such force as to bring one of his arms in violent contact with the man-hole frame, breaking it badly. The philosophy of this accident is that at first the boiler was filled with warm water and steam at a low pressure. This water was allowed to run out, leaving the steam to expand and fill the entire boiler. Cold water was then admitted, filling it to the top and condensing all of the steam. When this water was allowed to run out there was a partial vacuum formed in the boiler, so that there was an air pressure inside of, say, 8 pounds and 15 pounds on the outside, leaving a difference of about 7 pounds. As soon as the man hole cover was relieved of its fastenings and freed from its adhesive gasket, the air pressure forced it inward so that it landed about five feet from the boiler-head

The opinion has been expressed that some kind of gas must have been formed by the steam, the cold water and the heat, etc., but this is a mistake, for the above is a true explanation of the cause of the accident. If the safety-valve or some other outlet had been left open to allow the air to come and go as the water was admitted and expelled, there would have been no trouble.

If a joint in a steam-pipe leaks while under pressure, the hiss of the steam is very annoying, and while it may be plain that a short job with a caulking tool will make it all right, it is much better to wait until the pressure can be reduced, rather than attempt to do it while under full pressure. We know that the temptation is great, having been there ourselves, but the leak may be caused by a small crack in the cast-iron fitting. When the caulking tool is brought into use it of course wedges the iron in more tightly, putting an additional strain on the defective fitting, and causing it to break, filling the room with steam, which scalds the luckless engineer and does other damage. This has been repeated many times, and still men who have been in charge of plants for many years will do this, sometimes escaping accident, and at others receiving painful injuries.

Since crude petroleum and kerosene oil have come into use as boiler cleaners several accidents have occurred from injudicious use of lights in connection with the same A man in charge of a heating plant put five gallons of crude petroleum into his boiler for the purpose of removing the scale. After allowing it to remain there for some time, as the boiler had previously been emptied of the water that it contained, he thought he would like to see how the scale removing process was progressing. Accordingly he took a light and inserted it in the man-hole, but his ideas of the appearance of the inside of that boiler are rather confused, for he found himself about ten feet away, lying on the floor with his face, arms and body badly scorced and the clothing on fire. He had sufficient strength to make his way to the outside of the building, where his cries attracted attention and he was carried home, where he staid for many weeks. His experience was a bitter one, but he knows how to handle crude petroleum now to perfection. After it had lain in this boiler for a time, the light gases, which are exceedingly inflammable, arose to the surface, and when the light appeared they immediately ignited, causing an immense expansion of their volume, with the above result. In another place where crude petroleum was used in connection with a lime extracting heater, the engineer shut down the heater one day and took off the hand-hole covers for the purpose of cleaning it out, and took a light in order to better examine the interior. To his surprise an explosion was the result, for the inflammable gases were there and were not slow in making their presence known. If the heater had been well ventilated there would have been no trouble.

In another boiler-room they were making some experiments in burning crude petroleum for fuel, and had a barrel of it from which to supply the furnace fire. After using some of its contents the proprietor wished to know how much was left, and so removed the loose cover of the barrel and lowered a lighted lantern to see. The explosion which followed threw the burning oil up to the ceiling, and in a short time the whole boiler house was ablaze, and together with an adjoining wood-working and repair shop, was burned to the ground. He is still in doubt about the exact quantity of oil that was in the barrel. Several plans have been devised for heating the feed-water before it enters the boiler, and to promote the circulation of the whole body of water. Some of these consist of several pipes arranged along the sides of the furnace though which the water must pass before it enters the boiler. The natural consequence is that more or less sediment will lodge in these pipes, unless they are frequently and thoroughly blown out. In a certain plant where the boilers are fitted with settings of this kind, it was customary to blow them out twice each day. It was supposed that this was done in a thorough manner, but one day there was a tremendous hissing and roaring in one of the furnaces, from which clouds of steam issued. This soon extinguished the fire, and when the furnace was cooled off sufficiently to admit of an examination, it was found that one of the pipes were burnt out because it was almost completely filled with sediment baked as hard as a stone. This led to an investigation of the methods employed, and disclosed the fact that when the blow-off valve had been opened, the feed valve had been left open also, with the feed pump in full operation, the consequence being that instead of inducing a rapid flow of water through the setting, it only caused more water to be pumped directly from the source of supply through the blow-off into the sewer. This may appear like a great blunder, but as explicit directions had been given to the attendants as to the proper way to blow down, and no mention whatever was made of the feed-valve, it was only a natural mistake, and is one which all others who have similar devices to care for should studiously avoid. It is only justice to say that the patentee of the setting made all necessary repairs free of charge.

In another case an engineer, whose boilers had plain settings, heard a great commotion suddenly arise from under one of them, and the boiler-room was soon filled with steam and hot water. When the fog had cleared away it was found that the blow-off pipe had been burned off, and the boiler suddenly emptied of its contents. There are several reasons why a boiler should be blown down partially at short intervals, but where they are fed through one pipe and blown off through another, such practice is absolutely necessary.

It is not quite so bad to have the water in a boiler blown out during the night, when the fire is banked, for there is less danger of burning the sheets, but it is very unpleasant nevertheless, and where such an accident is repeated it shows conclusively that there is something wrong with the packing used or in the fit of the hand hole cover, for in one case that we know of the packing was partially blown out during the night, allowing all of the water to escape. In fitting hand-hole covers into place, it is well to put them in first with no packing on them, in order to make sure that they do not bind somewhere before they come properly to their seats, for as they are made tapering where they enter the hole, they may be held at two points and not touch the seat at all, and it is not easy to discover this defect after the packing has been put on.

In packing a man-hole cover care should be taken to use a thick, pliable gasket, as these surfaces are frequently not as true as they should be, and a thin gasket will not answer the purpose. An engineer who filled his boiler from a tank failed to use this precaution, and consequently lost about three-quarters of his supply. Any one who has had to run a steam pump by hand to fill up an 80 horse-power boiler knows just how to sympathize with him.

In another class of accidents the effect is to prevent us from getting water into our boilers, and so causing a shut-down. In one instance, where a battery of boilers were in use, the fireman could get no water into one of them, although there was no trouble to supply the remainder with all that was needed. Running it as long as he deemed it prudent to, he banked the fire and got the steam pressure off as soon as possible, and an examination showed that the valve disc in the feed-pipe had worked loose and finally became detached from the stem (it being a globe valve), and dropped down into its seat, and so prevented the pas-

sage of water through it. Now, it is quite true that if this valve had been put on with the other end towards the boiler, the water would have kept it from its seat, and this boiler need not have been laid off, but nevertheless, all things considered, we think that it was properly put on, because when shut the boiler pressure was under it, as it should be, and it could then be packed at any time, and furthermore, the fact that it was out of order was made known at once, whereas otherwise it probably would not have been discovered until it was necessary to shut off the boiler pressure for some purpose, and then it could not have been done. It is a good plan to use an asbestos packed plug cock in all such places as this.

Another engineer could get no water into his boiler, and concluded that his boiler was out of order. After spending about $100 in repairing the pump, he discovered that there was no water in the well, but he should not be too strongly condemned, as it was a driven well, and the defect was not easily discovered. In another case where the engineer could get but little water into his boiler, and there was plenty in the well, and his pumping apparatus was in good order, he found that his feed-pipe was so filled with sediment that but a very small passage remained open, hence the difficulty.

Sometimes an engineer gets more water than he can use to advantage, as was the case with one who returned from dinner and found his boiler-room filled with steam. He groped his way through it, started up his engine and blew the whistle at 1 o'clock, so there was no delay of the work in the shop. He raised the windows, and when the steam had partially cleared away discovered that one of the automatic sprinklers had melted out and was working at full capacity, the water coming into contact with steam pipes making the clouds of steam which filled the room. As it was, no great damage was done, but had it occurred early in the evening, and the water continued to run all night, it would have required several dollars to pay the bill. This was largely the fault of the engineer, for the sprinklers located in the shop were made to melt at a temperature of 165 degrees, while those in the engine and boiler rooms were supposed to require a temperature of 287 degrees, but by some oversight one of the former was put in the boiler-room, hence the accident.

It is well to have one or two extra man-hole guards in the boiler-room, for no one can tell when one of them will be needed. We remember a case where a fireman screwed up the nut on one of his man-hole covers so hard that it broke the guard in two, and he did not have an extra one to replace it. Fortunately it was not on Sunday, for the plant had been shut down for several days, during which time the boilers had been cleaned, but it was late in the afternoon, and a foundry in the neighborhood had poured off nearly all of the iron in the cupola. In a few minutes a pattern was found, it was put into service and a casting made out of about the last of the heat, and the guard was made that same evening.

In this connection we wish to speak of what was almost a serious accident, and should serve as a warning An engineer saw that one of the flange joints in a steam-pipe in his boiler-room was leaking. He seized a wrench and commenced to tighten up one of the nuts which held it, when the bolt twisted off, leaving but three to hold the flanges together. It did not take him very many minutes to find another bolt and put it into place. It was not a very large pipe, but then even one three inches in diameter will deliver steam enough at a high pressure to make matters very interesting, especially if it is suddenly discharged on an unsuspecting victim.

Many other accidents have happened in boiler-rooms, but enough have been mentioned to show that every man in charge of a boiler should be ever watchful, and never lose his presence of mind.

* * *

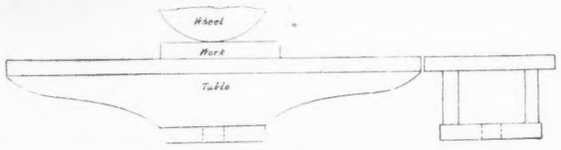
EMERY GRINDERS.

"SPIKE."

I have seen emery grinders and catalogues of emery grinders, but I never saw or heard of one so simple and yet so useful as one that I rigged up for surfacing small work, and I see no reason why a large one cannot be just as useful on large work.

All of the grinders that I ever saw had a traveling table, or else the wheel was under the table, with its edge projecting slightly through an opening in the center.

Now, I cannot say that I like either arrangement as well as the one I have, as they both have many objectionable features. The grinder with the traveling table must have the work strapped down or held in a vise, and in either case is pretty liable to get sprung out of shape. Besides that, it takes lots of time and patience to make the work come out just right. It is very much like a planer, any one can run the machine, but it takes a good man *to get it ready* to run. Another serious drawback is the fact that



the continuous grinding on one side will cause the work to hump up in the middle, and the more you grind the more it will hump, caused by the heat imparted to it by the wheel expanding the upper side. I have seen work ½ inch thick by 12 inches long strapped down at the ends and ground $\frac{1}{32}$ inch thin in the middle. And I find that after a time, if grinding thin stuff, the heat will also affect the table, and that will begin to rise also.

The grinder with the wheel under the table is all right if you want a bright surface, and are not particular about its being absolutely straight or parallel. It certainly won't make the work parallel unless it is so before the grinding begins.

No doubt the reader thinks I have "sat down" on emery grinders pretty hard, because it is well known that there are quantities of the best of work that comes from the emery grinder. But it takes lots of time and patience. What is wanted is a grinder that will turn off good work and a lot of it at a minimum cost, and I believe the one I have comes nearer possessing those points than any grinder I ever saw.

Now that I have run down the other grinders let me build up mine, although it is directly against my principles to do business that way, and wouldn't now if I were building grinders anywhere except on paper. And let me say right here that there is no patent, trade-mark, or anything else that I know of that prohibits any one rigging up as many as they like. There may be hundreds of them in use to-day for all I know, but I never saw or heard of one if there is.

To start with I had a small cutter grinder of I don't know whose make, as there is no name on it. It was a round standard of ordinary working height, with a spindle carrying the wheel, and running in two bearings at the top and an adjustable angle-iron gibbed to the side under the wheel, with vertical travel of 5 or 6 inches. To this angle-iron I fastened a table about 30 inches long by 9 wide as shown above, which was all the new parts I had to have to make my surface grinder complete. But as the grinder came more and more into use, I found it necessary to have various little attachments for different kinds of work, such as tongs for holding thin pieces while passing them back and forth under the wheel; also blocks and angle-irons for holding different shaped pieces while grinding the edges or surfaces that had no parallel base. A fixture for holding taper keys and similar work is shown below and needs no explanation, the object being to bring the grinding surface parallel with the table.

I find there is no limit to the length of work that can be ground on this style of grinder, unless you call the walls of the shop the limit, and it is easier to get the work parallel than otherwise. It is also possible to get out any number of pieces and not have them vary a perceptible amount in size, by grinding them one after another until the lot has been ground, and then adjust the

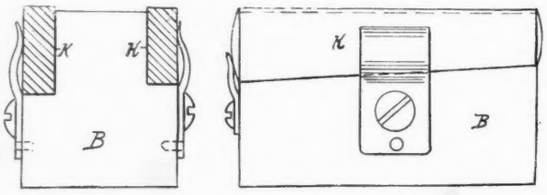


table for another "chip," and so continue until they have reached the size required. In this way they have a chance to get rid of the heat imparted to them by the wheel.

It is surprising what a variety of work can be done on this style of grinder, the quantity and quality is also something remarkable.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

CHIMNEY DRAFT.

In an article in your first issue, by W. Barnet Le Van, under the above caption, your readers were treated to some of the writer's views as to the cause of chimney draft. I am aware there are some very good ideas given in his article, but when it is stated that we do not know the cause of draft in chimneys when there is no fire in the furnace, I feel like offering my views on the subject. My opinion is that what may be termed the "natural draft" is the result of suction caused in the chimney by the wind or air passing over the top, for we all know that when a current of air is passing over a perpendicular tube it causes the air already in the tube to rush out in the same direction, and the larger the opening at the base of the tube the easier will be the flow of air, but the smaller the opening at the base the stronger will the passing top current cause it to suck up what air there is. This is fully demonstrated in the case of our old-fashioned open fireplaces in our houses. When you undertake to light a fire, how readily it will burn up if you cover up the open front with a large piece of sheet iron, leaving just enough open space to allow air to be sucked or drawn through the fuel. I am aware this appears the reverse in our modern stoves and furnaces, where, by opening the doors to a certain extent, you get more draught; but we must remember at the same time, if we open them beyond a certain limit, we allow the air to flow through too freely not as strong, and combustion is not so rapid.

I must confess I was more than a little surprised to read these statements from a man like the writer of said article, especially when the theory I hold has been proved beyond the possibility of a doubt, by a little instrument used in so many of our homes, viz.: the "atomizer." There is one tube reaches down into the reservoir for the perfumery, another tube is attached to the air-bulb, its outlet, passing just to the point of the tube reaching down to the liquid perfumery; as you press the bulb you force a current of air over the point of the tube going down into the reservoir, causing such a draft in the lower tube, not only extracting the air in it, but drawing up the liquid in such force as to send a fine spray quite a distance.

Again, our physicians make use of the same principle, when they wish the patient to inhale certain medicines while breathing, even when sleeping. I mention this because it may be argued that the pressure brought to bear on the air-bulb of the atomizer was so violent that it would in nowise compare with the chimney question, but the principle of the cause of draft is there, even by a weaker current, as the second illustration shows. Water is heated by means of a small spirit lamp, until the steam passing in vapor past the point of a tube reaching into the decoction to be inhaled; this vapor passing over draws out not only the air, but continuous small quantities of the medicine, which, being placed so that it will be guided close to the patient's nose and mouth, he receives the desired result. So I cannot see how any fact can be better demonstrated than that the cause of "natural draft" in chimneys is caused by passing air over the top of the stack. We all know draft is poor in chimneys when the air is still.

RICHARD FAIR.

OLD TIMES AND NEW.

In the reminiscences of Joshua Stevens, in the October number of MACHINERY, there are some of his opinions that I do not agree with. He says that he was satisfied with a dollar a day as an all-around workman, and that *now* workmen want from three to four dollars a day for shorter hours than he worked.

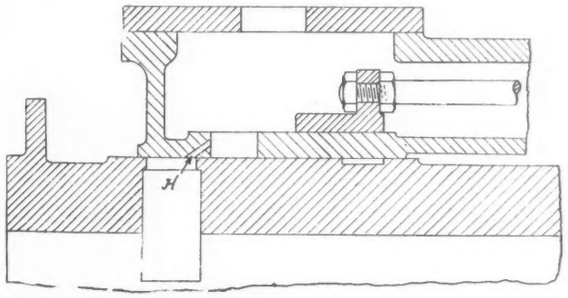
But judging from the tools he described, and the method of doing work, a machinist would be more able to *earn* three or four dollars a day now than in those times. I don't think a workman gets paid for any more than he earns; I think that if he gets three or four dollars a day he generally earns it. Mr. Stevens also writes that the "prevailing practice of machine shops is bad for the coming generation, and is producing a class of men who are good for nothing outside of the routine work they are engaged on." A great many young men who are not mechanically inclined, but must have something to do to earn a living, drift into the machine shop. They do not care enough about the business to advance themselves in it. Some machine shop managers take advantage of this, and put them to work on one special thing, giving them a little more than a common laborer's wages, and making in reality *operators* out of them, not machinists This has a tendency through competition to keep wages down, and tends to prevent a good mechanic from getting what he should be entitled to. A good all-around workman of to-day, although he may not be able to chip and file as smooth as they used to, has to have a good deal more knowledge than he did fifty years ago, and also has to be able to read drawings intelligently, an accomplishment which, I presume, few workmen had in those times.

AN ALL-AROUND WORKMAN.

ABOUT BUCKEYE ENGINES.

Your correspondent, W. L. Jones, in the October number of MACHINERY, refers to the Buckeye engine generally as not doing well when working with a condenser, and tells how a friend remedied the trouble by adding lap to the valve until sufficient compression was secured. The Buckeye engine will pound when a condenser is applied to it, unless the valve has been prepared for it. This fact has been known to the Buckeye Co. for many years, and the remedy is simple and effective. Adding exhaust lap cannot have much effect unless there is a poor vacuum, for there can be no compression unless there is something in the cylinder to compress, and if the vacuum could be perfect compression would be impossible. If there is a good vacuum then a large amount of exhaust lap would be needed to get enough compression, and the more lap there is the later will be the exhaust opening, which is very objectionable.

The better plan is to secure an early lead by drilling holes from the valve face through into the valve port, as shown at H in the accompanying sketch, which shows a section of one end of a Buckeye valve. If the holes are the right size, or of sufficient combined area, the effect will be the same as compression on the



non-condensing engines, and the engine will also run as quietly as without a condenser. The lead line on the indicator card will look just like the non-condensing compression curve if the holes are of the right area and properly located. Care must be taken to have the holes come through the valve face so that no steam can enter the cylinder port from the holes until the valve has completely closed the port so steam cannot blow out into the exhaust pipe. Buckeye valves usually have what they call "gain lead," which is a series of curved notches in the admission edge of the main valve port, which admits the steam gradually by the point of the notch before the rest of the edge opens. The advance of this notch might be increased to get the same effect as the holes produce, but the holes are safer, because if desired they may be easily plugged if there are too many, or if they are no longer needed. The Buckeye engine has many peculiarities, and if an engineer is not familiar with them and has difficulty in getting them to run well, it would be a good idea to write to the builders, who, from a long experience, have learned their peculiarities and can give an engineer in a few words many points about their operation which it would take months for the engineer to learn by experience.

BELL CRANK.

* * *

DON'T let a repair job go away from the shop because you can't do it, for the man who can do it will get all the work next time. The repair shop that gets the reputation of doing any job that comes along gets all the good jobs, which make up for an occasional "hard" one, that is unprofitable.

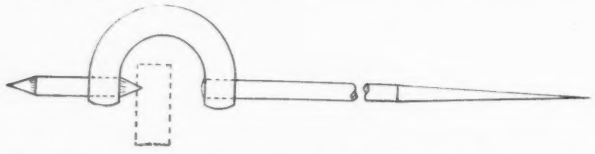
* * *

AN ample allowance for power required in average shop practice will be made by considering a 13-inch engine lathe as requiring ½ a horse power as a maximum.

MACHINERY'S NOTE BOOK.

A CHEAP CENTER INDICATOR.

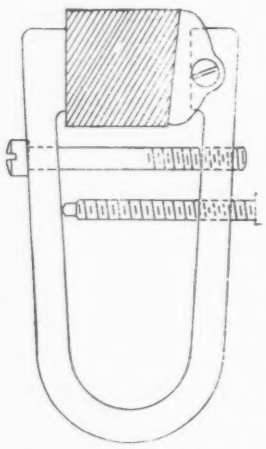
Of the many forms of center indicators that have come under the writer's notice, none is more cheap or simple than the one shown, and the results are very satisfactory. The semi-circle of fairly heavy steel, ⅜ inch round or square, with the other pieces of steel rod $\frac{5}{16}$ or ¼ inch, completes the tool. The short center can be of such length as to suit the work, 2½ inches will be ample for most cases, while a pointer 8 or 9 inches long will show very small variations. For those who may not be familiar with its use a little explanation may be needed. Having, for example, a piece of cast iron four inches square which we wish



to drill, bore and thread exactly in the center of its square face. We carefully lay out the center with scale and dividers, and make a center punch mark at the correct point. Now chucking it as accurately as possible by the eye, our center indicator comes into use. Take the back end of a lathe tool and make a punch mark in it for the inside end of the small centre-rod, as shown by the dotted lines, and move the carriage up to the work till the other end of this short center enters the punch mark on the wor . It is best to have the lathe tool adjusted so that the punch mark comes fairly near the center line between the lathe centers, but this is not essential to the use of the indicator. Now revolve the lathe by hand, and it will be evident on a moment's thought that if the center punch mark in the work is exactly true with the lathe spindle, it will simply revolve and not move in circle, as it would if it was an inch out of center, and consequently the indicator will simply be idle and the long pointer will show no movement. But if the punch mark is $\frac{1}{16}$ of an inch out of center, as it probably will be at the first trial, the small center will travel with it and the end of pointer will move in a circle as much larger than the real error, as the distance from the long end to the center against tool is longer than the the short rod, or from tool to work. By this means we can detect very small errors, as the long pointer will show a movement when the real error is so slight we could not detect it without the indicator. A little study will show that the exact position of the punch mark in the tool is not essential, though for convenience it can be adjusted near the center. Better make one if you have work of this kind to do.

A FILING OR PLANING GAUGE.

The original of this, with plain jaws, as shown by the dotted outline on the right, was found in a lot of sewing-machine scrap, which had been sold at auction, and had evidently been a hand vise for light work, or a clamp for special purposes. The upper screw adjusts the jaws, while the lower one forms a check or lock, preventing an accidental alteration in size. For planing or filing parallel pieces it is found much more convenient than ordinary calipers, as it bears across the whole surface and shows high spots; in fact, is practically a solid steel gauge for any size within its limits. The addition of the jaw or shoe, as shown on the right, overcomes the angularity due to various movements of the jaws, and also allows the gauge to be used for work that is not parallel, the screw shown clamping it in any desired position. For getting out cutters for sectional taps and boring bars it is extremely handy, whether they are planed or filed, as the required angle can be set and the cutter filed to it much more readily than to the dovetail slot in the bar itself. It is a very convenient addition to any tool-makers kit, and has a wide application.



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THE Manhattan Silver Plate Co. are running their factory at Lyons, N. Y., up to 9:15 every night.

FRESH FROM THE PRESS.

Standard Electrical Dictionary, Prof. T. O'Connor Sloane; 8vo., 624 pages, 350 illustrations; Norman W. Henley & Co., New York. Price, $3.00.

Now that nearly every engineer has a lighting plant in connection with his other duties, he must of necessity become more or less familiar with the rudiments of electric lighting and dynamos in general. For this purpose we know of nothing better than this book, which is more than a dictionary and as much of an encyclopædia as space permits. Much can be learned by a careful study of such portions as interest the reader, and as a work of reference it is of great value to any one at all interested in electricity.

Practical Application of the Indicator, Lewis M. Ellison, C. E.; 195 pages, 100 illustrations. Price, $2.00. Address author, 25 West Lake street, Chicago.

This gives in plain language such information as the practical engineer desires, illustrates points that are often obscure, such as the causes of serrated expansion and compression lines, and will give an engineer as good an idea of the indicator and its uses as any book we have seen and better than some. A careful study of the book, in connection with an intelligent use of the indicator as directed, will result in gaining much knowledge in this direction

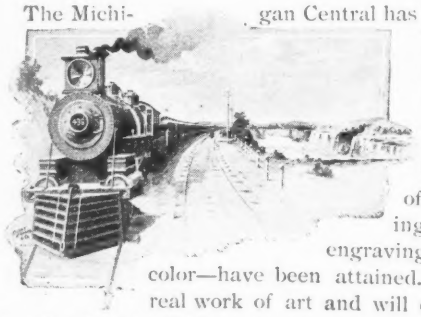
THE *Aluminum World* a monthly journal of 20 pages and cover, for the manufacturers of aluminum and its alloys and the metal industry in general, has made its appearance Those interested in the metal will find articles by Dr. C. W. Hayes, Alfred E. Hunt, Prof. Joseph W. Richards, James C. Ashton, and others. It has our best wishes for success. Mr. Palmer H. Langdon is editor, and Mr. Theodore Wilders, manager. Subscription rates, $2.00 per year.

THE *Engineering Magazine* has enlarged its field of reviews, and now presents the reviews of each department of mechanics and science entirely separate, and with an independent index. This greatly increases its usefulness, and the busy man can see very quickly all that pertains to his particular line. It is to be congratulated on it enterprise, which will be appreciated by its readers.

Dixie has been urging International Expositions as a means of trade extension into Mexico and South America, which has met with considerable approval by manufacturers, and President Diaz also favors the project. The next thing is to decide upon a city in which to hold the convention of manufacturers to organize for the work, and all interested are invited to communicate with The *Dixie* Company, Atlanta, Ga.

* * *

The Michi- gan Central has long been noted for the luxurious character of its advertising literature, but in the latest production of this road, "Comfort in Travel," the perfection of this class of book making—paper, typography, engraving, and combination of color—have been attained. This little book is a real work of art and will delight anyone with an eye for the beautiful.



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THE new catalogue of The David Maydole Hammer Co., of Norwich, N. Y, is very neat, and clearly shows the variety of hammers made by the company, giving the weight and general appearance of the tools, and should aid in making selections from the stock.

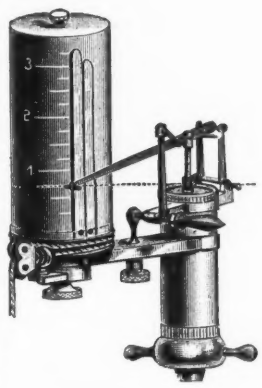
* * *

FOR many years mechanics throughout the country firmly believed that only Eastern manufacturers could turn out first-class tools. The Cleveland Twist Drill Co. take great pleasure in stating that the quality of their goods has been recognized by the awarding to them a gold medal at the Antwerp Exposition, and cite this as an indication that "Westward ho the course of empire takes its way."

* * *

THE Goulds Mfg. Co., Seneca Falls, N. Y., are running full time. They are now busy on two 10 by 12 triplex electrically driven water works pumps, for De Kalb, Ill.

No Good Indicator



ROBERTSON THOMPSON.

PRICE, COMPLETE, $40.

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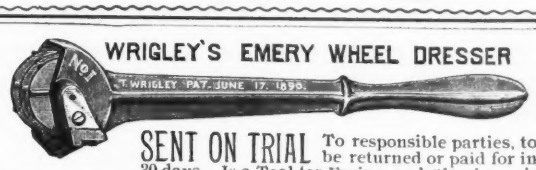

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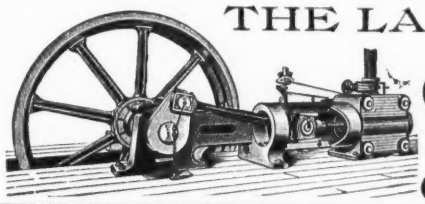

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The only Tubular Heater with settling chamber below the tubes, or that will extract the oil from the exhaust.

The Otis Heater has one square foot of heating surface per horse-power.

It will heat the feed water 210 or 212 degrees with the exhaust steam, without causing any back pressure.

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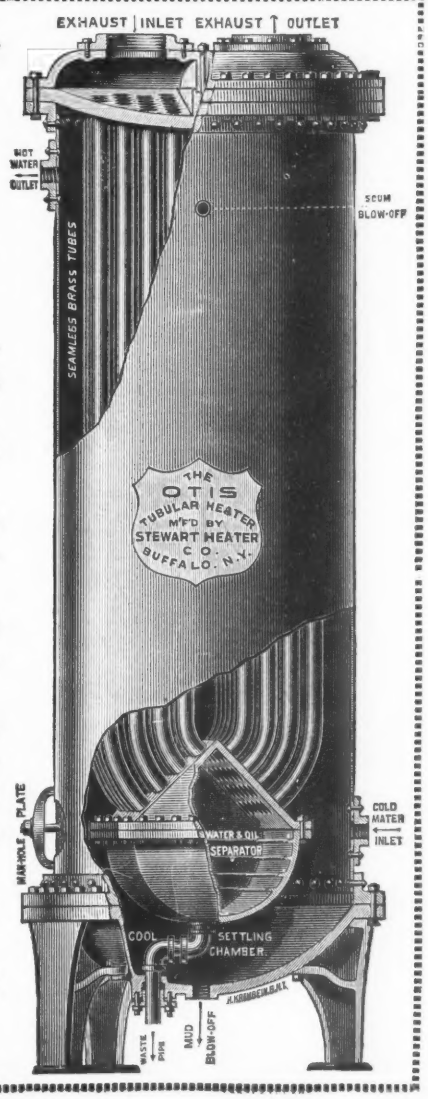

Work and Workmen.

UNDER this heading we will insert want advertisements for 5 cents per line (seven words) each insertion. Copy must reach us by the 25th of the month preceding issue. Replies may be sent care of MACHINERY, 411-413 Pearl Street, New York, if desired.

SITUATION wanted by practical engineer and machinist. Five years chief engineer and foreman of repair shop in acid works. Thoroughly understands erection and repairs of engines, ice machinery, boilers, etc. Address
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* * *

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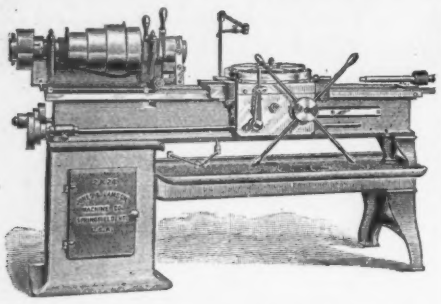

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Saves all Blacksmith Work.
90% Tool Steel. 60% Grinding.
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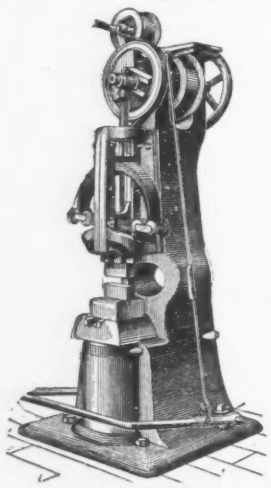
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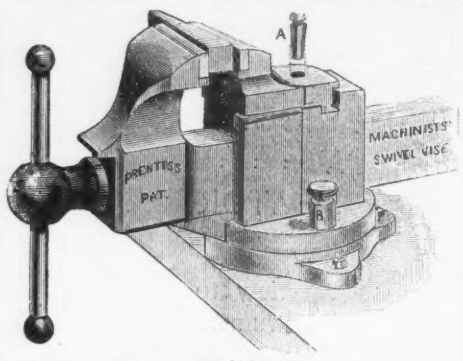
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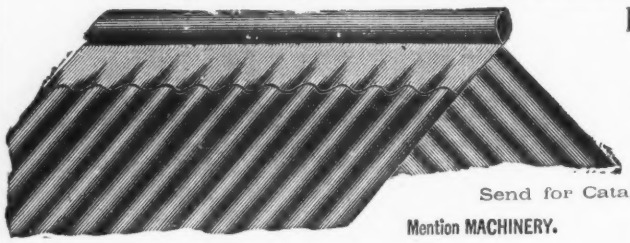
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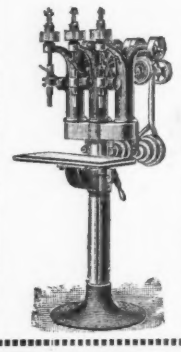
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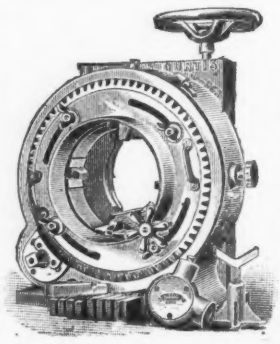
A complete tool; being all that is required to thread & cut off pipe and the only profitable hand machine in the market with which one man can cut off and thread large pipe up to 8 inches diameter without assistance while with the smaller sizes of machines a boy will thread two and three inch pipe with only one hand on the crank. Send for complete catalogue of Pipe Cutting and Threading Tools.
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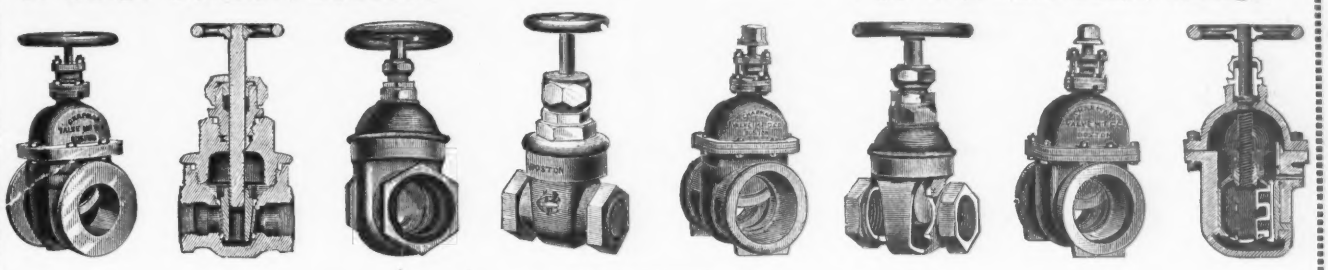

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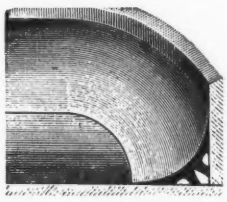

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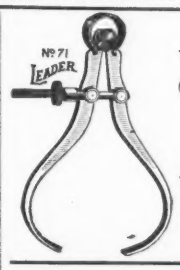

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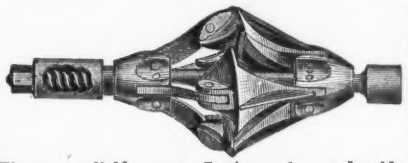

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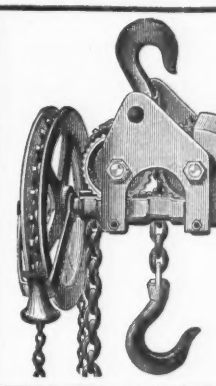

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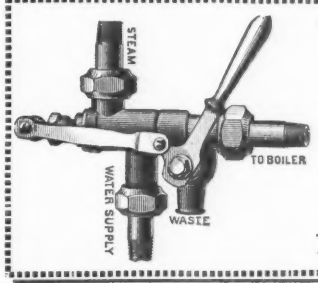

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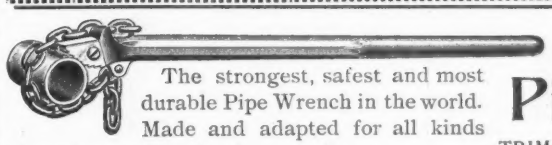

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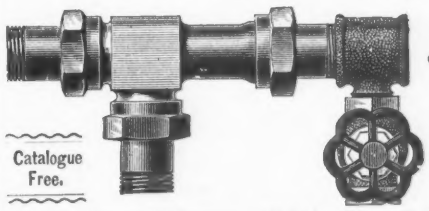

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WILL WORK
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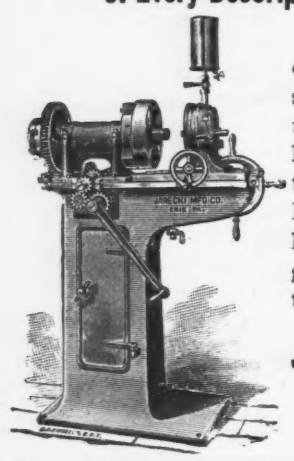

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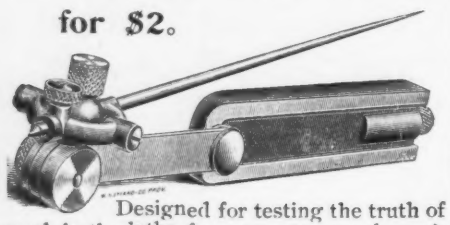

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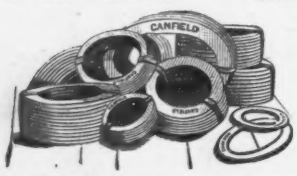

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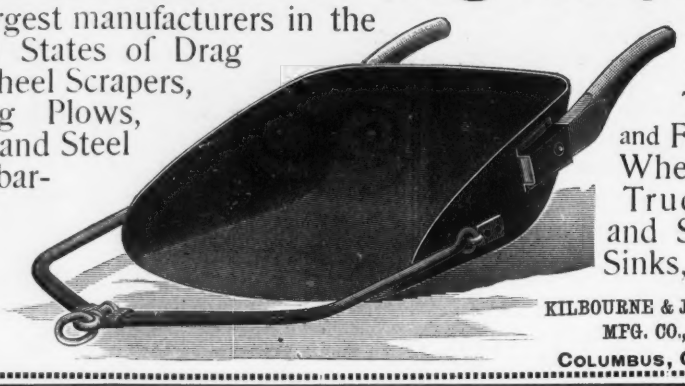

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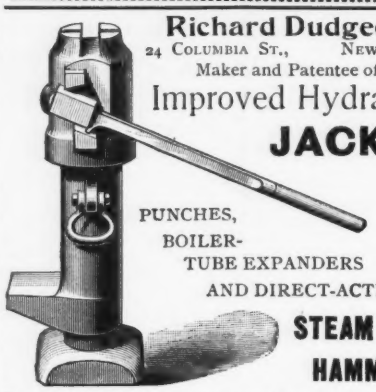

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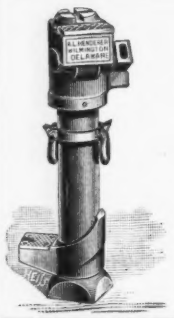

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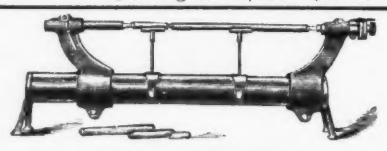

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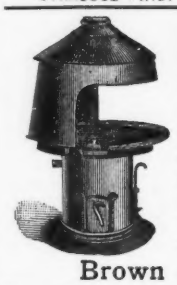

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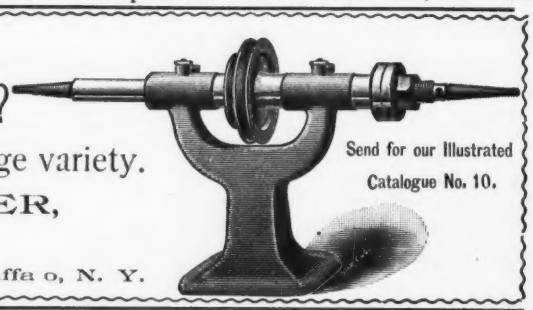

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—ESTABLISHED 1855.—

THE GUTTA PERCHA AND RUBBER MFG CO.,

MANUFACTURERS OF

MECHANICAL RUBBER GOODS OF EVERY KIND,

35 WARREN STREET, NEW YORK.

New York, Chicago San Francisco, Portland, Ore.

Belting, Packing, Springs, Steam Hose, Etc.

...omatic devi...
the pu... ...ng a pump, ... lubricant is taken from and flow... ...eservoir in t... ...se, strainers being provided.

* * *

JUST what is best for journals and bearings is one of the things that seriously puzzle the man who starts out to design machines and machinery. Morin, who did a good deal in the way of friction and the like, never settled it to his own liking, and of course not to the liking of anyone else. There was, perhaps, never a question over the superiority of the old-time hammered steel shaft. There is some question as between the steel shaft of commerce of the present day and a good hammered iron shaft. That question was raised fifteen years years ago, and has not been settled up to the present writing. "All steel shafts" used to have a good deal to do with the matter when the steel cost the most money. There was something to talk about. It has lost this advantage.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

42. J. S. H. Please tell me a simple way of finding the dimensions of a worm to be cut in a lathe. The wheels are generally cast instead of being cut, and as the drawings give us only the pitch, pitch circle and diameter of the worm, we have no way of finding out how to shape a tool to cut the thread at the right angle. *A*. The drawings ought to show a section of the worm parallel with its axis and give the dimensions of the teeth shown in section. Without this you have no means of knowing how to shape the tool. Worm gearing is generally constructed so that a tool with straight sides and an angle of about 30° between them, will be right to use. This may or may not be correct in your case.

43. H. A. C. writes: Please give me a reliable formula for a solution for coating blue-print paper. *A*. Blue-print paper can now be bought coated, ready for use, from any dealer in drawing materials, and most draughtsmen prefer to use it, as it is more convenient. In case you do not have much printing to do, however, you may prefer to prepare your own paper. The following solution gives good results:

Red prussiate potash (recrystallized)...	1 part	(by weight).
Citrate of iron and ammonia.....	1 "	"
Water.....	10 "	"

In mixing the solution, first weigh and pulverize the potash and dissolve it in the required weight of water, afterwards add the iron, which does not need pulverizing. If the chemicals are dissolved in separate bottles of water they will keep better than if mixed, as the light will not affect them. 2. What is the best paper to use for blue-printing? The solution soaks into the paper that I have and makes spots. *A*. "Helios" paper, for sale by the Keuffel & Esser Co., New York, gives good results. It comes in rolls of various widths and thicknesses. To prevent spotting, the paper must be coated quickly and hung up to dry.

44. F.M.A. writes: I have seen so much printed on the safety-valve and the proportions of the same that I want to study into the question for myself. Kindly inform me how high an ordinary weighted valve will lift. *A*. From .05 to .10 of an inch; the higher ...e pressure the lower the lift. 2. Is there a good rule for cal...ting the weight of steam that will flow out? *A*. To get ...u pounds per second, add 15 to the gauge pressure, in ...s, multiply by the area in inches and divide by 70. Note ... area meant is not the area of the valve, but the area ...ening to the air, which is equal to the circumference of ...ultiplied by the lift. For example, let the boiler pres... ...ads and area of opening two square inches. Then ...; 75 × 2 = 150; 150 ÷ 70 = 2.14 pounds per second. ...er's rule for the flow of steam, and one of the best. ...ks: How is the economy of gas engines affected ...oad? Does an under-loaded engine show a loss ...me as in the case of a steam engine? *A*. Yes. ...f a 12 HP. gas engine has been furnished us ...ing results: One HP., 48 cu. ft. of gas per ... 18 cu. ft.; 8 HP., 16 cu. ft.; 12 HP., 15

WHAT ME...

THIS COLUMN IS OPEN FOR TH... OF INTEREST, TECHNICA... ONE SIDE OF THE PAPE...

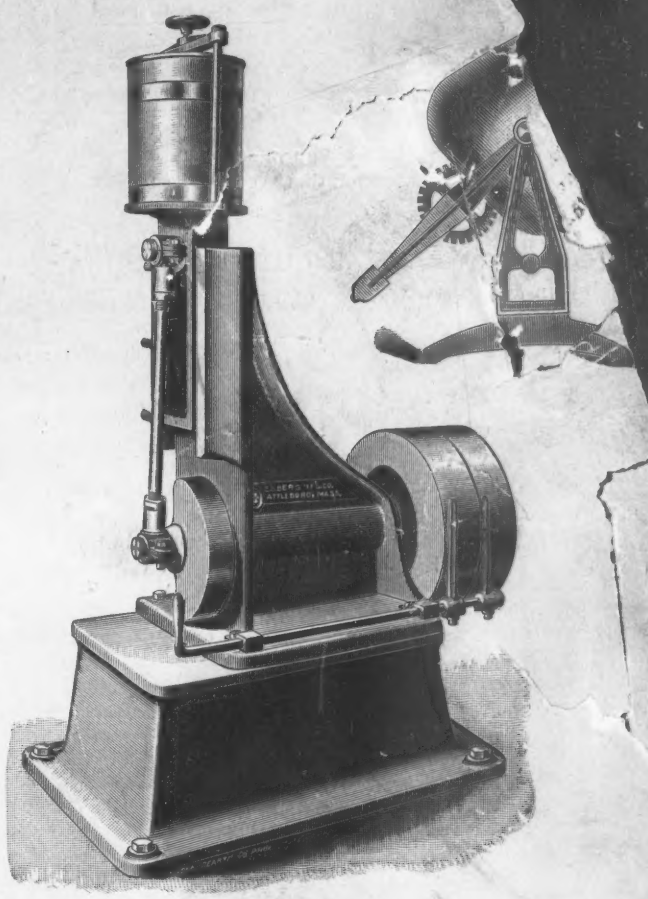
WHEN SKETCHES ARE NECESSARY TO ILL... NO MATTER HOW ROUGH THEY M... ARE PROPERLY ...

For the best practical idea sent us e... we will send a copy of Usher's "Moder... "Shop Kinks." For the next best we will en... year to MACHINERY to any desired address. ... any idea that is worth publishing, we will se... Cheney's "Machine Shop Arithmetic."

FINISHING PRESS WO...

Perhaps a few hints on the best met... punched work may be of interest to some ... have the good or bad fortune to have charge...

Some years ago I took charge of a large... great variety of both iron and brass work... things the superintendent said to me was: ... is, but we have never been able to do pre... which we buy from outside. We hire the... can get, and take a good deal of care in fi... dies, but somehow the work never seems to ... it ought to, and I wish you to see if you can fi...



Well, I started in, and before night found out what the matter was, and sent a requisition to the office for a tumbling barrel like the one shown in the first sketch. I got called to the office on it at once. Said they didn't see what I wanted of it, but finally they were prevailed upon to order it. The trouble was the work was being sent out of the press room just as it came from the dies, all grease and dirt and more or less scrap mixed with the same. The tumbling barrel arrived and was set up, and pretty soon the press room began to get lots of compliments which was not a common occurrence in the factory. It wasn't that kind of a shop.

The best thing to use for finishing work with the barrel is old broken emery wheels, but when the supply of these runs short, a few cinders from the ash pile will do nearly as well. Of course, a liberal supply of good hard-wood saw-dust is also essential.

The cut does not show up the barrel as well as it should. The

…ate split thimble …terposed …ner or othe… a smooth drive. Th… anges of … …ed by shifting the belt from o…e cone to … …utters are set from a fixed point not subject to …ar, and … always be set central with the work spindle, regardless of th… wear of the cutter slide.

The feed has a wide range of evenly graded variations, and is driven by worm and worm wheel. The forward movement of the cutter slide is driven by a positive clutch, insuring a positive feed for the cutter, and the return movement by a friction clutch, which receives the shock of the reversal and thus reduces the strain on the feed mechanism. The hand wheel, for operating the feed screw by hand, disconnects automatically and remains stationary when not in use.

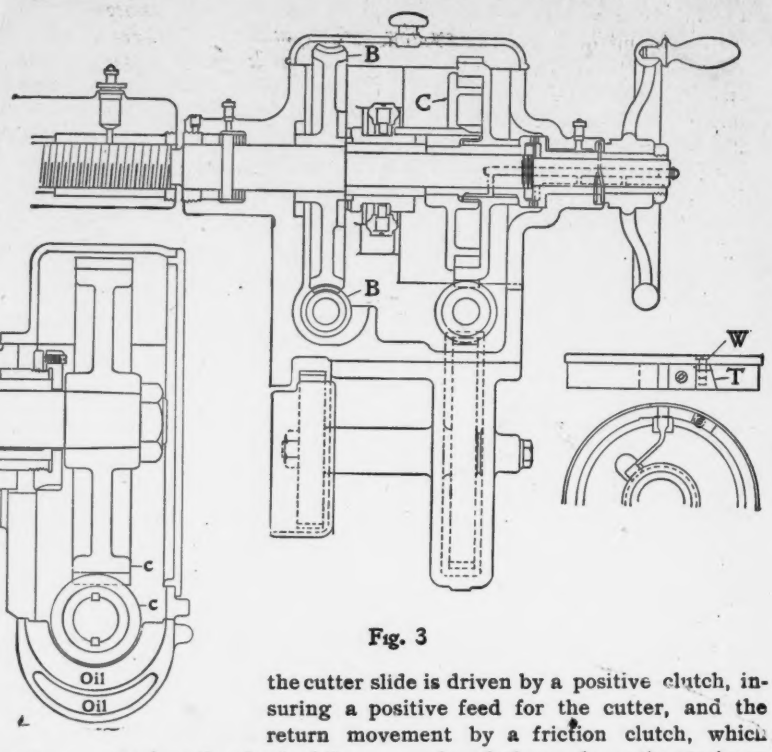


Fig. 3

Figs. 2 and 3 show details of the drive and feed respectively. In the former, A is the cutter spindle and C C are the spiral driving gears. In the latter, B B are the worm and worm wheel for the positive drive during the cut, and C is the friction clutch used for the return. This is shown more in detail in the lower right hand corner of Fig. 3, where the method for adjusting the clutch by the screw W, and wedge T, is indicated.

The work spindle slide is moved up and down on the upright by a screw, operated from the front of the machine, and a dial reading to thousandths of an inch enables the depth of cut to be accurately determined. The larger machines are furnished with outer supports for the work spindle.

Great care is taken to have the index wheel very accurate, and it is large in diameter in proportion to the diameter of the work. The indexing mechanism is unusually rapid and error in its action is practically impossible. When the machine is cutting, the indexing mechanism is at rest and not subject to the strains of a constantly revolving friction. The drive for returning the cutter slide and for indexing is independent of cutter drive and feed, and the return of cutter slide a… speed of indexing mechanism are the s… whatever the speed or feed of cutter.

Provision is made to allow for re-cut… setting a gear without loosening the… the arbor or the arbor on the spindl… ping the teeth of the change gears…

A withdrawing expansion arbor … with the larger machines, and ca… back through the work spindle, a… ished gear to be removed and th… without disturbing any of the… the outer support or of the work spindle slide.

The driving gears and worms run in oil, … provided inside the base of the machine … and for holding lubricant. The chips fall …

…ate split thimble …terposed …ally as set forth.

…leys illustrated and described …nts of the first claim exactly. …te, and they clearly anticipate …

…hird claim of the patent) there …t difference in opinion. Judge …on, holds that the split …r its equivalent, for the rea… …n of the patent states that the …wood. He, however, curiously … other particulars by stating:

…tion referred to in the first claim …ooden and metallic pulleys, and, …mbles referred to in the third claim …metallic or wooden separable pulleys.

…s can recall what they have seen …split bushings, of wood or other-

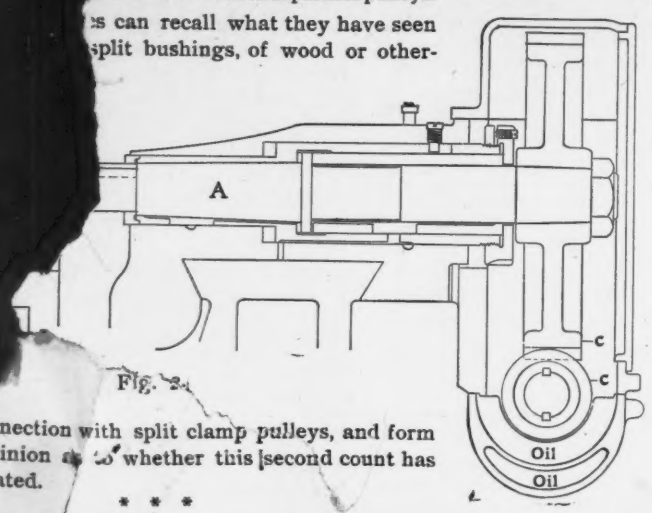


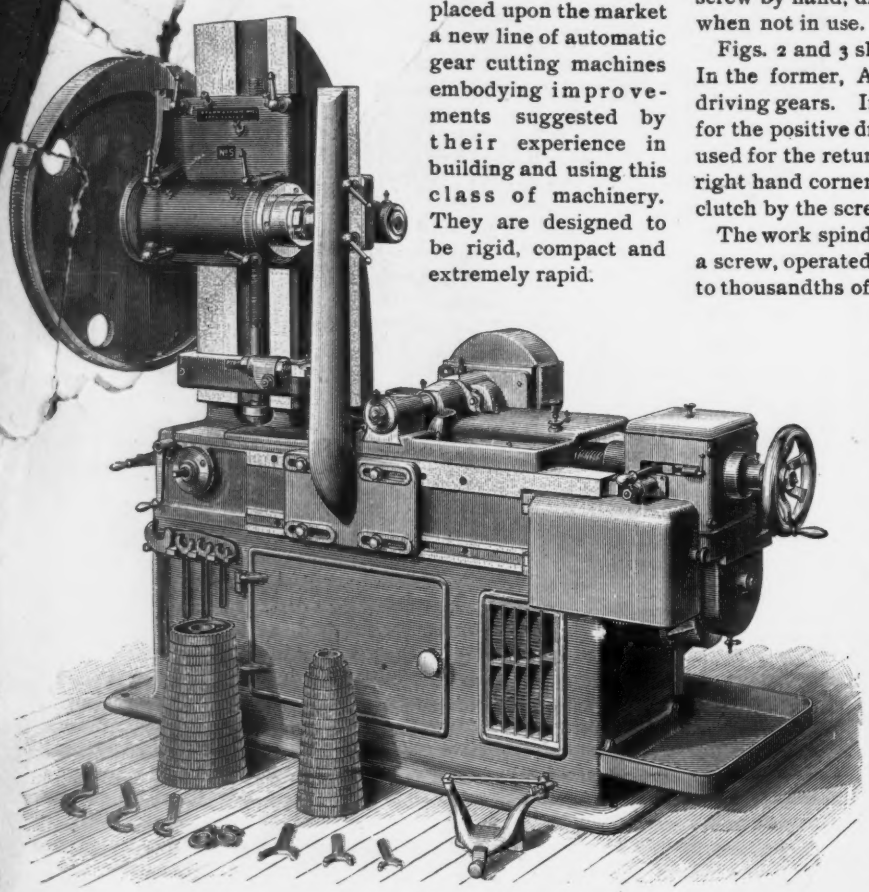
Fig. 2.

…nnection with split clamp pulleys, and form … opinion … whether this second count has …icipated.

* * *

… AUTOMATIC GEAR CUTTING MACHINES.

Brown & Sharpe Mfg. Co., of Providence, have recently placed upon the market a new line of automatic gear cutting machines embodying improvements suggested by their experience in building and using this class of machinery. They are designed to be rigid, compact and extremely rapid.



NEW AUTOMATIC GEAR CUTTING MACHINE.

The illustration shows one size of the machine and is typical of the different sizes.

The cutter spindle is supported on both sides of the cutter, and is driven by spiral gears, which does away with the belt-

Established, 1828.

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15 AND 20 IN. **Crank Shapers**

Six Hundred in Use.

Stroke adjustable while running . . .
Stroke always positive. . . . . .
The vise is swiveled, and centres furnished.
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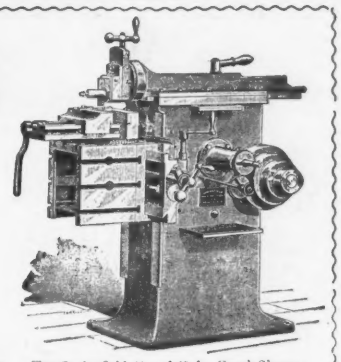

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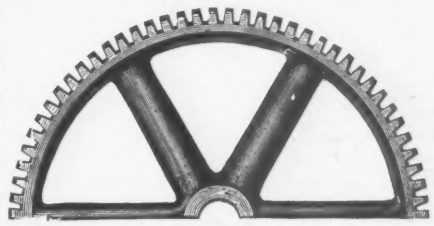

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DETROIT, MICHIGAN.

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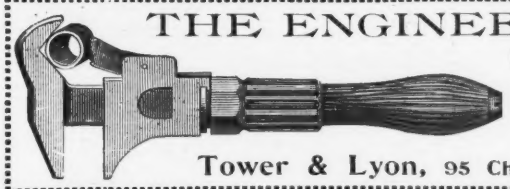

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Steel Drop Forged.

All Parts Interchangeable.

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Morton's Reversible

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Joints are not forced apart when at work as with Pushing Cut. Drawing Cut does more work than can be done the old way—combining ACCURACY and RAPIDITY.

Machines guaranteed and sold on trial.

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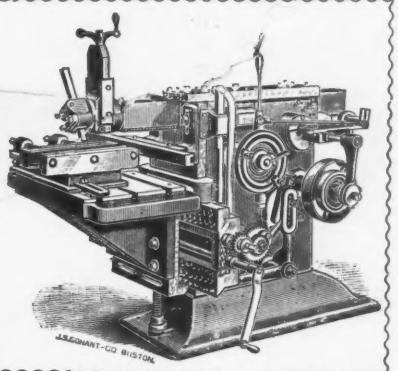

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Has index lines on column, stop on pinion shaft and spindle so arranged that the drill will not catch. Fitted with chuck for spindle, bell and dead centers and V's for drilling transversely through cylindrical forms; also with a 4-inch chuck for centering shafts without first finding center by other methods. Send for circular. Every machine warranted.

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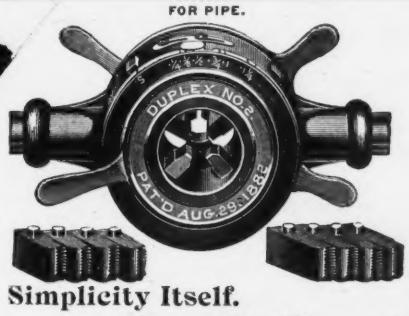

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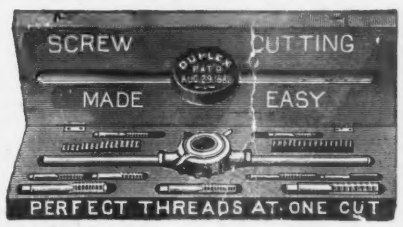
Adjustable
Die Stock.

30,000 in daily use.



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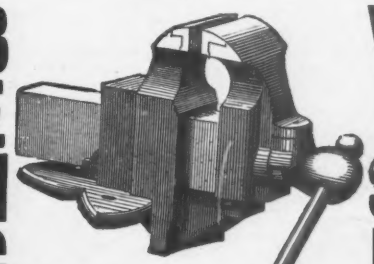

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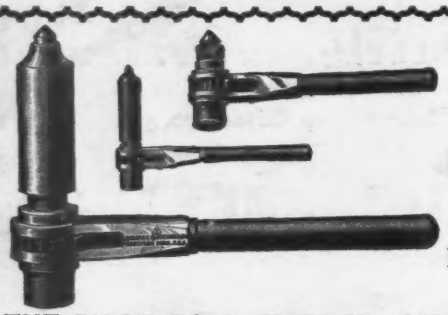
Mention MACHINERY.



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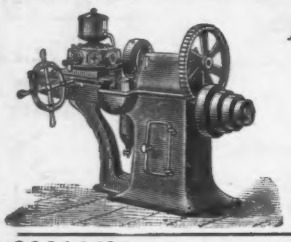

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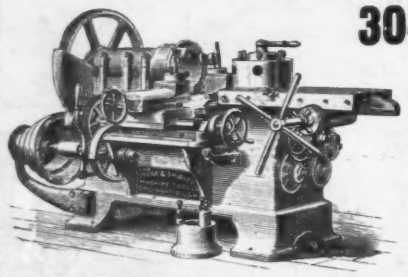

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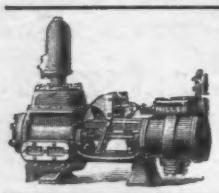

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And shall be pleased to submit particulars.

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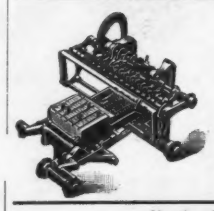

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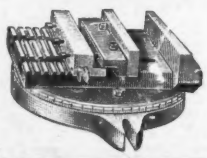

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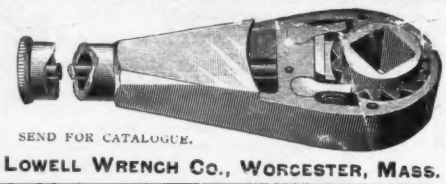

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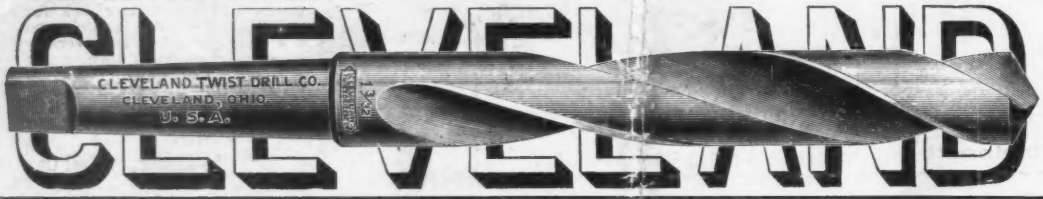

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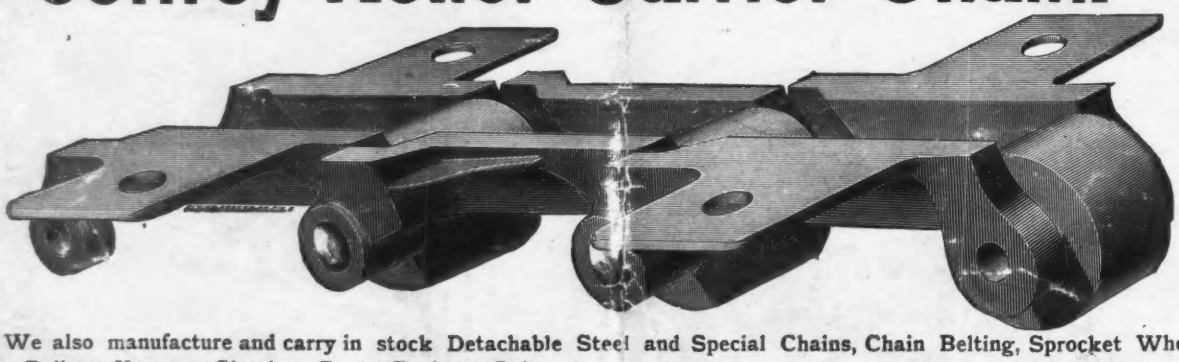

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